

The NEW HAMPSHIRE CLEAN POWER STRATEGY

**An Integrated Strategy to Reduce Emissions
of Multiple Pollutants from
New Hampshire's Electric Power Plants**

January 2001

**NEW HAMPSHIRE DEPARTMENT OF
ENVIRONMENTAL SERVICES**



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January 2001

**The Honorable Jeanne Shaheen
Governor**

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Commissioner**

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LIST OF ACRONYMS AND DEFINITIONS

| | |
|-------------------|---|
| Anthropogenic | Man-made |
| BACT | Best Available Control Technology |
| BART | Best Available Retrofit Technology |
| Biogenic | Naturally occurring |
| CAA | The federal Clean Air Act |
| CEMs | Continuous Emissions Monitoring Systems |
| CFR | Code of Federal Regulations |
| CO ₂ | Carbon Dioxide |
| DES | New Hampshire Department of Environmental Services |
| Env-A | New Hampshire Code of Administrative Rules Governing the Control of Air Pollution |
| EPA | United States Environmental Protection Agency |
| HAPs | Hazardous Air Pollutants |
| Hg | Chemical Symbol for Mercury |
| ICR | Information Collection Request (issued by EPA) |
| ISO | Independent System Operator |
| LAER | Lowest Achievable Emission Rate |
| lb/MWh | Pounds per megawatt-hour of electricity generated (an output-based measure) |
| lb/mmBtu | Pounds per million British thermal units of heat input (an input-based measure) |
| MACT | Maximum Achievable Control Technology |
| mmBtu | Million British thermal units |
| MWh | Megawatt-hours of electricity |
| MOU | Memorandum of Understanding |
| NAAQS | National Ambient Air Quality Standard(s) |
| NEG/ECF | New England Governors Conference and the Eastern Canadian Premiers |
| NESCAUM | Northeast States for Coordinated Air Use Management |
| NHCPS | New Hampshire Clean Power Strategy |
| NO _x | Oxides of Nitrogen |
| OTAG | Ozone Transport Assessment Group |
| OTC | Ozone Transport Commission |
| PBTs | Persistent Bioaccumulative Toxic Compounds |
| PM _{2.5} | Fine Particulate Matter |
| PSNH | Public Service Company of New Hampshire |
| RACT | Reasonably Available Control Technology |
| SCR | Selective Catalytic Reduction |
| SO ₂ | Sulfur Dioxide |
| VOCs | Volatile Organic Compounds |

The NEW HAMPSHIRE CLEAN POWER STRATEGY: An Integrated Strategy to Reduce Emissions of Multiple Pollutants from New Hampshire's Electric Power Plants

Executive Summary

Despite significant air quality improvements over the last two decades, recent scientific analyses have demonstrated that adequate protection of New Hampshire's public health, environmental quality, and economic well-being requires additional, concerted reductions in air pollutant emissions. The quality of life enjoyed by New Hampshire's citizens – as well as the State's economic success in the “new economy” – hinges on this protection. Moreover, aggressive additional reductions in air pollutant emissions will further enhance the state's tradition of environmental leadership, a tradition that has been remarkably successful in motivating similar environmental measures at the regional and national level.

Of particular concern is the fact that fossil fuel-burning electric power plants continue to emit substantial quantities of several harmful air pollutants despite a solid history of emission reduction efforts. In part, this is because power plants that were constructed prior to the Clean Air Act Amendments of 1977 were “grandfathered” (i.e., not required to meet the same stringent emission limits as newer power plants). Recognizing these facts, several Northeastern states have begun to address “grandfathered” power plant emissions much more aggressively through various legislative and regulatory solutions.

Acting at the direction of Governor Jeanne Shaheen, the New Hampshire Department of Environmental Services (DES) has developed a plan to constructively and cost-effectively achieve significant additional reductions in emissions of four important air pollutants from New Hampshire's electric power plants. By implementing one integrated strategy that comprehensively addresses sulfur dioxide (SO₂), oxides of nitrogen (NO_x), mercury, and carbon dioxide (CO₂), policy makers can provide New Hampshire's electric generators with the certainty and flexibility they need to meet clean air goals in the most cost-effective way. In addition, a comprehensive, integrated approach involving multiple pollutants allows generators to take advantage of the collateral benefits (“co-benefits”) created when measures to reduce one pollutant assist in reducing emissions of other pollutants. Finally, a crucial aspect of this comprehensive strategy is the use of flexible, cost-effective, market-based measures, such as trading and banking of emission reductions under a strictly controlled and monitored overall emissions cap. Such “cap and trade” approaches have proven to be extraordinarily effective in curbing air pollution – reducing some emissions 30 percent more than required by regulations.

This document represents DES's recommended approach. DES's strategy – the **New Hampshire Clean Power Strategy (NHCPs)** – will substantially reduce emissions of these four harmful pollutants from all existing large, fossil fuel-burning electric power plants in New

Hampshire, namely Merrimack Station in Bow, Newington Station in Newington, and Schiller Station in Portsmouth.¹ The NHCPS is based on the following principles:

- ***Environmental effectiveness*** –
The NHCPS recommends emission caps based on electricity generated, rather than fuel used, in order to encourage greater efficiency and more pollution prevention;
- ***Cost-effectiveness and flexibility*** –
The NHCPS includes compliance flexibility provisions (e.g., banking and trading) to maximize environmental benefits with the least possible compliance cost and impact on electric rates;
- ***Integration and comprehensiveness*** –
The NHCPS recommends new, substantially lower emission caps for four key power plant pollutants: oxides of nitrogen (NO_x), sulfur dioxide (SO₂), mercury, and carbon dioxide (CO₂) to improve both air and water quality;
- ***Multiple benefits (or “co-benefits”)*** –
The NHCPS provide multiple benefits in two ways; first, by addressing many air pollution-related public health and environmental problems simultaneously; and second, by encouraging facilities to utilize progressive control measures and technologies that reduce emissions of several air pollutants at the same time;
- ***Annual application*** –
The NHCPS applies all of these new limits on a year-round basis rather than only during certain seasons;
- ***Substantial lead time*** –
The NHCPS recommends timeframes which will provide owners of the affected power plants with substantial lead time in which to develop and implement control strategies before the new requirements take effect;
- ***Sound science*** –
The NHCPS is based on the latest available science regarding impacts to public health and environmental quality;
- ***Proven, effective, reliable technology or control measures*** –
The emissions caps recommended in the NHCPS are reasonably achievable with a combination of existing control technologies, market-based measures, operational changes, and developing technologies;
- ***“Clean hands”*** –
Consistent with New Hampshire’s past environmental leadership, the NHCPS sets an example for other jurisdictions to follow; and
- ***Consistency with Legislative policy*** –
The NHCPS is consistent with the New Hampshire Legislature’s expectations for environmental improvement under electric deregulation, as embodied in RSA 374-F:3, VIII.

¹ NHCPS does not apply to the two new combined cycle natural gas burning power plants under construction in New Hampshire (i.e., Newington Energy in Newington and AES Granite Ridge in Londonderry). As new facilities, these plants are already subject to more stringent federal and state environmental regulations, including requirements to install state-of-the-art technology to provide the “Lowest Achievable Emission Rate (LAER)” for NO_x emissions, and “Best Available Control Technology (BACT)” for all other criteria pollutants. In addition, natural gas is inherently a much cleaner fuel.

Consistent with these principles, the NHCPS sets aggressive emission reduction targets for all four pollutants at New Hampshire's existing large, fossil fuel-burning electric power plants, including:

- A **75 percent** reduction in annual SO₂ emissions, above and beyond the Phase II requirements of Title IV of the federal Clean Air Act (i.e., the Acid Rain Program) that just took effect in 2000, reducing total New Hampshire SO₂ emissions from these sources by 89 percent since 1990;
- A **70 percent** further reduction in annual NO_x emissions, above and beyond the 68 percent annual (76 percent seasonal) NO_x reduction that New Hampshire has already achieved, reducing total New Hampshire NO_x emissions from these sources by 90 percent since 1990;
- A **75 percent** reduction in annual mercury emissions from coal-burning power plants compared to recent (1996/1997) emissions; and
- A **7 percent** reduction below 1990 CO₂ emission levels, reducing annual CO₂ emissions from these sources to approximately 10 percent below current annual New Hampshire CO₂ emissions.

NHCPS recommends the following timeframes for implementing these reductions:

- In 2006, an annual SO₂ emissions cap of 7,289 tons (derived by multiplying 1999 total MWh by 3.0 lb/MWh) would take effect;
- In 2006, an annual NO_x emissions cap of 3,644 tons (derived by multiplying 1999 total MWh by 1.5 lb/MWh) would take effect;
- In 2006 or as soon as appropriate control technology is commercially available, an annual mercury emissions cap of 82 pounds (derived by multiplying recent mercury emissions by 25 percent) would take effect for coal-burning facilities; and
- In 2006, an annual CO₂ emissions cap of 5,046,055 tons (derived by multiplying estimated 1990 total CO₂ emissions by 93 percent) would take effect.

The adoption and implementation of the NHCPS will enhance quality of life for all New Hampshire citizens. Nevertheless, due to transported air pollution, a complete solution to air quality problems in New Hampshire depends on the implementation of a similarly comprehensive multi-pollutant emission reduction strategy on a much broader regional or national basis. New Hampshire's environmental leadership – in adopting the NHCPS – will contribute materially to achieving this outcome. However, a regional or national solution, when developed, is likely to differ somewhat from any individual state's approach. As a result, New Hampshire may need to modify some of the NHCPS's provisions to comport with a regional or national solution, provided that such a solution achieves similar or greater emission reductions within an aggressive timeframe.

Since federal regulations for some or all of these four pollutants may change in the future, the NHCPS should be updated as necessary in order to ensure that its public health, environmental, and economic benefits to New Hampshire citizens are retained to the greatest degree possible. Moreover, the emission reductions recommended by the NHCPS are designed to address numerous environmental and public health problems. For several of these problems, including fine particulate matter and regional haze, direct regulation has not been recommended in the

NHCPS because these concerns arise indirectly, largely through atmospheric transformations involving SO₂ and NO_x, pollutants which the NHCPS does recommend limiting. If, after implementation, the NHCPS's anticipated benefits regarding regional haze or fine particulate matter do not materialize, it may be necessary to develop programs to regulate these pollution problems directly.

By definition, the NHCPS focuses on emissions reductions from existing power plants in New Hampshire. This is due to the relative volume of emissions from these sources and the relative cost-effectiveness of controlling them through market-based measures. However, DES has supported or developed other national, regional, and local strategies to achieve similar reductions from other emission source categories, and it will continue to do so. The NHCPS is not a "silver bullet" that will eliminate the need for all other emission reduction efforts. Rather, it is intended to implement one key component of DES's overall *Clean Air Strategy*. DES will continue to pursue implementation of this and other *Clean Air Strategy* components on a local, regional and national basis, as appropriate, in order to broaden the public health, environmental, and economic benefits that sustain New Hampshire's quality of life.

The NEW HAMPSHIRE CLEAN POWER STRATEGY (NHCPs): An Integrated Strategy to Reduce Emissions of Multiple Pollutants from New Hampshire's Electric Power Plants

1. INTRODUCTION

1.1. Air Pollution Progress in New Hampshire

The State of New Hampshire has demonstrated significant environmental leadership in reducing its air pollution. New Hampshire's Acid Rain and Air Toxics emission control programs were both adopted years before their federal counterparts. New Hampshire has achieved the greatest percentage reduction in NO_x emissions of all States in the Ozone Transport Region, was the first state to implement a year-round NO_x emission cap, and the installation of selective catalytic reduction (SCR) technology to control NO_x emissions at Public Service of New Hampshire's (PSNH) Merrimack Station was the world's first use of SCR on a coal-fired wet bottom cyclone boiler. Figures 2-2 and 4-4 show that 1999 emissions represent a 25 percent and a 68.5 percent reduction from baseline SO₂ and NO_x emissions, respectively, resulting from these efforts.

In addition, according to EPA's *Toxic Release Inventory*, New Hampshire has been at or near the top nationally in reductions of toxic air emissions during the last 12 years. The State was also one of the first states to work specifically on controlling emissions of persistent bioaccumulative toxic compounds (PBTs) to the environment. New Hampshire introduced a *Mercury Reduction Strategy* in 1998 that has already resulted in a 37 percent decrease in statewide mercury emissions, and is currently developing the nation's first state dioxin reduction strategy. Further, New Hampshire was the first state to hire a full-time climate coordinator and to implement a voluntary greenhouse gas emission reduction registry.

1.2. Air Pollution Problems in New Hampshire

Despite these considerable achievements, significant public health and environmental challenges still remain. Combustion emissions continue to form microscopic soot particles that are dangerous to breathe and which impair visibility. Although improving, ozone "smog" still plagues areas of New Hampshire on hot summer days at concentrations unhealthy for children and adults with chronic respiratory ailments such as asthma. Acid compounds carried by rain, snow and fog fall year-round, compromising our forests, wildlife, and water, aquatic, and cultural resources. Nitrogen-laden pollutants accelerate the eutrophication and nitrification of our lakes. Heavy metals like mercury, and persistent, bioaccumulative toxins like dioxin continue to build up in the food chain. Scientists have determined that greenhouse gas emissions, like carbon dioxide (CO₂), are starting to alter the earth's climate, an impact that could profoundly affect public health, quality of life, and several important sectors of New Hampshire's economy. Concentrations of several toxic

compounds in the air we breathe have been estimated by the U.S. Environmental Protection Agency (EPA) to exceed health risk screening levels everywhere in New Hampshire.²

A recent study conducted by Abt Associates³ using EPA methods concluded that airborne fine particulate matter is responsible for 67 premature deaths, 46 hospitalizations, and 1,540 asthma attacks annually in New Hampshire. A study by the Health Effects Institute (HEI) linked heart attacks to even moderate levels of air pollution. Extensive new scientific research shows that the air pollution routinely found in many U.S. cities may trigger sudden deaths by changing heart rhythms in people with existing cardiac problems. Epidemiologists in about 90 cities around the world consistently have found that more people are hospitalized and die during periods when particulate pollution increases, even by only moderate amounts. Rarely does such an evident epidemiological pattern of health effects emerge.⁴

“Quality of life” has been characterized as a stool held up by three legs: (1) healthy bodies; (2) healthy ecosystems; and (3) a healthy economy. Air pollution in New Hampshire compromises our bodies, damages the State’s sensitive ecosystems; impairs our recreational, natural resource, and other industries. In short, air pollution puts New Hampshire’s cherished quality of life at risk.

1.3. New Hampshire’s *Clean Air Strategy*

To aggressively address these continuing threats to New Hampshire’s health, environment, and economy, the New Hampshire Department of Environmental Services (DES) is updating its *Clean Air Strategy*, first published in 1994. The *Clean Air Strategy* is a comprehensive, statewide effort to reduce emissions of all air pollutants of concern, from all sources. The goal of this strategy is to improve public health, environmental quality, and economic opportunity in New Hampshire by reducing fine particulate matter, ground-level ozone (or “smog”), acid deposition, mercury and other air toxics, greenhouse gas emissions, eutrophication, and regional haze. Although these problems are numerous, Table 1-1 shows that they are largely attributable to just four critical air pollutants: sulfur dioxide (SO₂), oxides of nitrogen (NO_x), mercury (Hg), and carbon dioxide (CO₂).

² U.S. Environmental Protection Agency, *Cumulative Exposure Project*, 1999, and *National Air Toxics Assessment* (ongoing). See <http://www.epa.gov/cumulativeexposure/> and <http://www.epa.gov/ttn/uatw/nata/>. Also see <http://www.des.state.nh.us/ard/ceplist.htm>

³ Abt Associates, Clear The Air’s National Campaign Against Dirty Power, *Health Impacts Analysis*, October 17, 2000. See <http://www.cleartheair.org>

⁴ The Health Effects Institute, *National Morbidity, Mortality, and Air Pollution Study, Parts I & II*, June and October 2000. See <http://www.healtheffects.org>

TABLE 1-1. Major Public Health and Environmental Concerns Addressed by a Four-Pollutant Approach

| Concern | SO ₂ | NO _x | Mercury | CO ₂ |
|----------------------------------|-----------------|-----------------|---------|-----------------|
| Acid Deposition (“Acid Rain”) | • | • | | |
| Fine Particulate Matter (“Soot”) | • | • | | |
| Ozone (“Smog”) | | • | | |
| Mercury Contamination | | | • | |
| Eutrophication & Nitrification | | • | | |
| Climate Change | | | | • |
| Regional Haze | • | • | | |

Source: DES and US EPA

Emission sources are classified into three general groups in the *Clean Air Strategy*. “Stationary sources” (also known as “point sources”) include power plants and large industrial or institutional emission sources like factories, large office buildings, hospitals, etc. “Mobile sources” include motor vehicles of all types, as well as trains, aircraft, construction equipment, agricultural equipment, etc. “Area sources” (often referred to as “Other Sources”) are small commercial and residential emission sources like gas stations, bakeries, dry cleaners, autobody shops, offices, homes, etc. The four pollutants listed in Table 1-1 are emitted in varying amounts by the sources within each of these categories. Table 1-2 shows how emissions from these source categories compare. (See also Figures 2-3, 2-4, 3-1, 5-2, and 7-4.)

TABLE 1-2. Approximate Source Share of Four Pollutant Emissions in New Hampshire, 2000

| Source | SO ₂ | NO _x | Mercury | CO ₂ |
|---------------------------------|-----------------|-----------------|----------|-----------------|
| Power Plants | 81% | 20% | 40% | 30% |
| Other Industrial Sources | 9% | 8% | 38% | 10% |
| Mobile Sources (Transportation) | 7% | 57% | Unknown* | 37% |
| Area Sources (Other Sources) | 3% | 15% | 22% | 23% |

* – EPA has not yet developed emission factors for transportation sources.

Source: DES and US EPA

As Table 1-2 makes clear, power plants emit a particularly large proportion of these four problematic pollutants that cause serious air pollution-related impacts on public health, ecosystem damage, and the economy in New Hampshire. While there is no question that much progress has been made in the last decade to reduce emissions from these power plants (their NO_x emissions, for example, were once about 50 percent of the total, and SO₂ and particulate matter emissions are also down substantially), power plants are still responsible for a significant share of the air emissions generated in New Hampshire and remain a focal point of the revised *Clean Air Strategy*.

1.4. Public Concerns About “Grandfathered” Power Plants

Public health, environmental, community, and consumer organizations have raised concerns in several states – including New Hampshire – about the disproportionate public health and environmental impacts that result from the SO₂, NO_x, mercury, and CO₂ emitted from large, old power plants that were constructed prior to the Clean Air Act Amendments of 1977. All three of New Hampshire’s existing fossil fuel-burning power plants (Merrimack Station in Bow, Newington Station in Newington, and Schiller Station in Portsmouth) were built before 1977, and two of them (Merrimack and Schiller) burn coal.

The 1977 Clean Air Act did not require older generating facilities to meet more stringent emission standards because Congress expected that these plants would soon be retired and replaced with newer, cleaner, more efficient generating facilities. Instead, most old plants have continued to operate beyond their anticipated useful life,⁵ taking full advantage of their “grandfathered” status relative to the new emission standards. Table 1-3 lists background information for the three “grandfathered” facilities in New Hampshire.

TABLE 1-3. “Grandfathered” Power Plants in New Hampshire

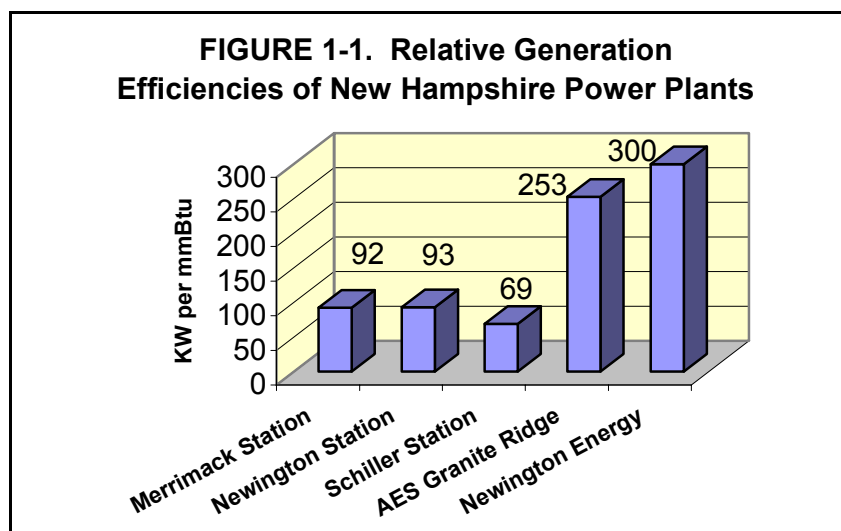
| Plant | Location | Boilers (“Units”) | Fuel Used | Capacity (MW) | Start-Up Date |
|-------------------|------------|-------------------|------------|---------------|---------------|
| Merrimack Station | Bow | 2 | Coal | 434 | 1960 |
| Newington Station | Newington | 1 | Oil or Gas | 406 | 1974 |
| Schiller Station | Portsmouth | 3 | Coal* | 119 | 1949 |

* – Also capable of burning minor amounts of oil.

Source: DES

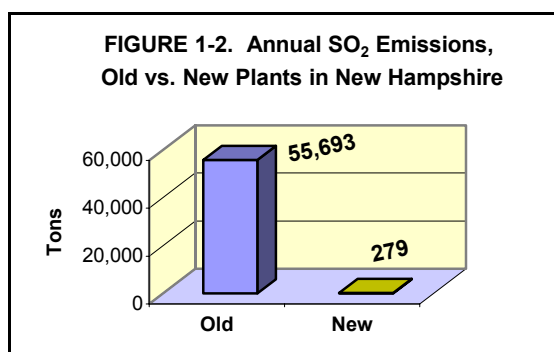
These older power plants are characterized both by lower generation efficiencies (by reason of their age) and higher pollutant emissions (by reason of more lenient federal regulation), as compared to newer facilities. Figures 1-1 through 1-5 illustrate this point. Figure 1-1 shows the relative generation efficiencies (i.e., kilowatts generated per million British thermal units of heat input) for New Hampshire’s three existing coal- and oil-burning power plants and those anticipated from the two new natural gas-burning power plants under construction in the State, AES Granite Ridge in Londonderry and Newington Energy in Newington. As this figure illustrates, the new technology plants generate electricity approximately three times more efficiently than the older “grandfathered” power plants in New Hampshire.

⁵ The Clean Air Network, 2000. See <http://www.cleanair.net/PowerPlants/campaign.htm>

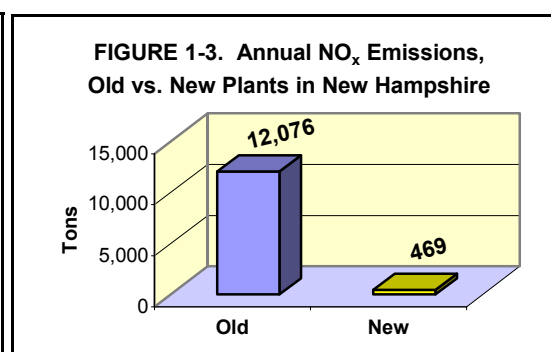


Source: DES

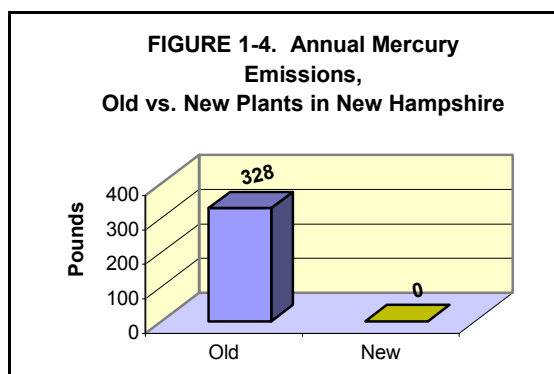
Figures 1-2 through 1-5 illustrate the comparative total emissions of SO₂, NO_x, mercury, and CO₂ respectively for the same old and new power plants in New Hampshire. These figures reflect 1999 actual emissions from the three existing power plants (1996 for mercury), and permitted (allowable) emissions for the two new power plants under construction in New Hampshire.



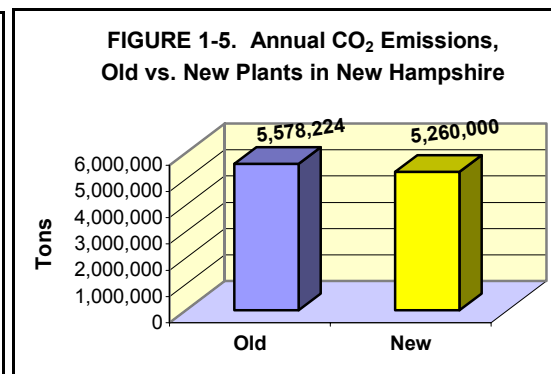
Source: DES



Source: DES



Source: DES



Source: DES

Although actual emissions depend on plant capacity factors (i.e., the proportion of time that a plant actually runs), these comparisons are even more sobering when generating capacity is considered. Combined, the generating capacity of the existing “grandfathered” power plants is 959 MW. The generating capacity of the two new natural gas-burning plants is 1245 MW, or nearly 30 percent higher, despite their dramatically lower emissions.

As noted above, new facilities are subject to much more stringent federal emission control limits. As a result, these facilities have to incorporate the cost of pollution control (i.e., the cost of cleaner air and water) into the price of their product (electricity). By contrast, the older “grandfathered” power plants usually operate without similar controls, and thus have not had to build the cost of a cleaner environment into their pricing structures. This uneven treatment (between old and new power plants) effectively creates an “environmental subsidy” for the old, “grandfathered” plants. The cost of the additional emissions from these facilities (so-called “environmental externalities”) is thus shifted from the power plant owner to the individuals and businesses that are subjected to the additional pollution, many of whom are not even customers of the facilities. These costs show up in the form of increased health care costs and human suffering, lower forest productivity, loss of habitat, less enjoyable views, reduced tourism, and higher public expenditures to control flooding, address drought, repair erosion, maintain beaches, replenish fish stocks, etc.

Since higher pollutant emissions lead to unacceptable public health affects, environmental impacts, economic effects, public expenditures, and even political conflicts (e.g., interstate arguments over transported air pollution), the public’s interest in competitive parity among electric generators coincides with the public’s interest in better health, an improved natural environment, a more robust economy, enhanced quality of life, and setting an example for upwind jurisdictions. Both interests require that all large, electric generating facilities in New Hampshire – old and new – receive equitable environmental treatment.

1.5. The New Hampshire Clean Power Strategy (NHCPS)

Acting at the direction of Governor Jeanne Shaheen, DES has developed the New Hampshire Clean Power Strategy (NHCPS), which focuses on reducing emissions of four interrelated compounds (NO_x, SO₂, mercury, and CO₂) that threaten New Hampshire’s quality of life – our health, our environment, and our economic well-being. A very large share of these four pollutants is emitted by just three facilities in the State. Of these three sources, all continue to operate as “grandfathered” power plants, subject to much less stringent emission limits than similar new sources. When substantial impact emanates from so few sources, a concerted public policy response with respect to those sources is warranted.

Two additional dynamics also compel prompt, comprehensive action to reduce power plant emissions. First, because power plants are such large emitters of so many pollutants, significant opportunities exist to reduce multiple pollutants simultaneously through wisely chosen control strategies. The opportunity to achieve multiple benefits (also known as “co-benefits”) through “two-for-one” or “three-for-one” reductions contrasts markedly with traditional, expensive pollutant-by-pollutant regulatory approaches. An exercise conducted in 1999 modeled the multiple pollutant reductions that would occur in New Hampshire under an integrated approach designed to secure such co-benefits within the electric generation

sector.⁶ Its results showed that one set of reasonable measures would simultaneously reduce SO₂ emissions by 49 percent, NO_x by 46 percent, particulates by 48 percent, and CO₂ by 31 percent. (Mercury emissions were not modeled as part of this exercise.)

Second, New Hampshire is approaching the final stages of deregulating its electric utility industry, and RSA 374-F:3, VIII specifies how environmental improvement is to accompany that process. Its statutory provisions include leveling the environmental playing field (i.e., eliminating “grandfathering”) and encouraging long-term sustainability, market-based approaches like trading, and environmental leadership on the part of the State.

In order to address (1) the risks to New Hampshire’s quality of life that power plant emissions represent; (2) the opportunities that integrated approaches offer for significant, simultaneous reductions of multiple pollutants and their harmful effects; and (3) the New Hampshire Legislature’s expectations for environmental improvement under electric deregulation as embodied in RSA 374-F, DES has developed this plan – the New Hampshire Clean Power Strategy.

The following chapters describe the need for, character of, and costs and benefits associated with implementing the NHCPS. Chapters 2-9 illuminate the significant public health and environmental concerns associated with pollution from existing, coal- and oil-burning electric power plants. Although the NHCPS specifically targets power plant emissions, as noted above the New Hampshire *Clean Air Strategy* addresses all pollutants and sources. Chapter 10 summarizes power plant initiatives now underway in other states that are similar to the NHCPS, and describes New Hampshire’s efforts to reduce SO₂, NO_x, mercury, and CO₂ emissions from sources other than power plants. Chapter 11 describes the NHCPS and its implementation in detail. Chapters 12 and 13 detail the anticipated benefits and estimated costs of the NHCPS, and Chapter 14 concludes the strategy.

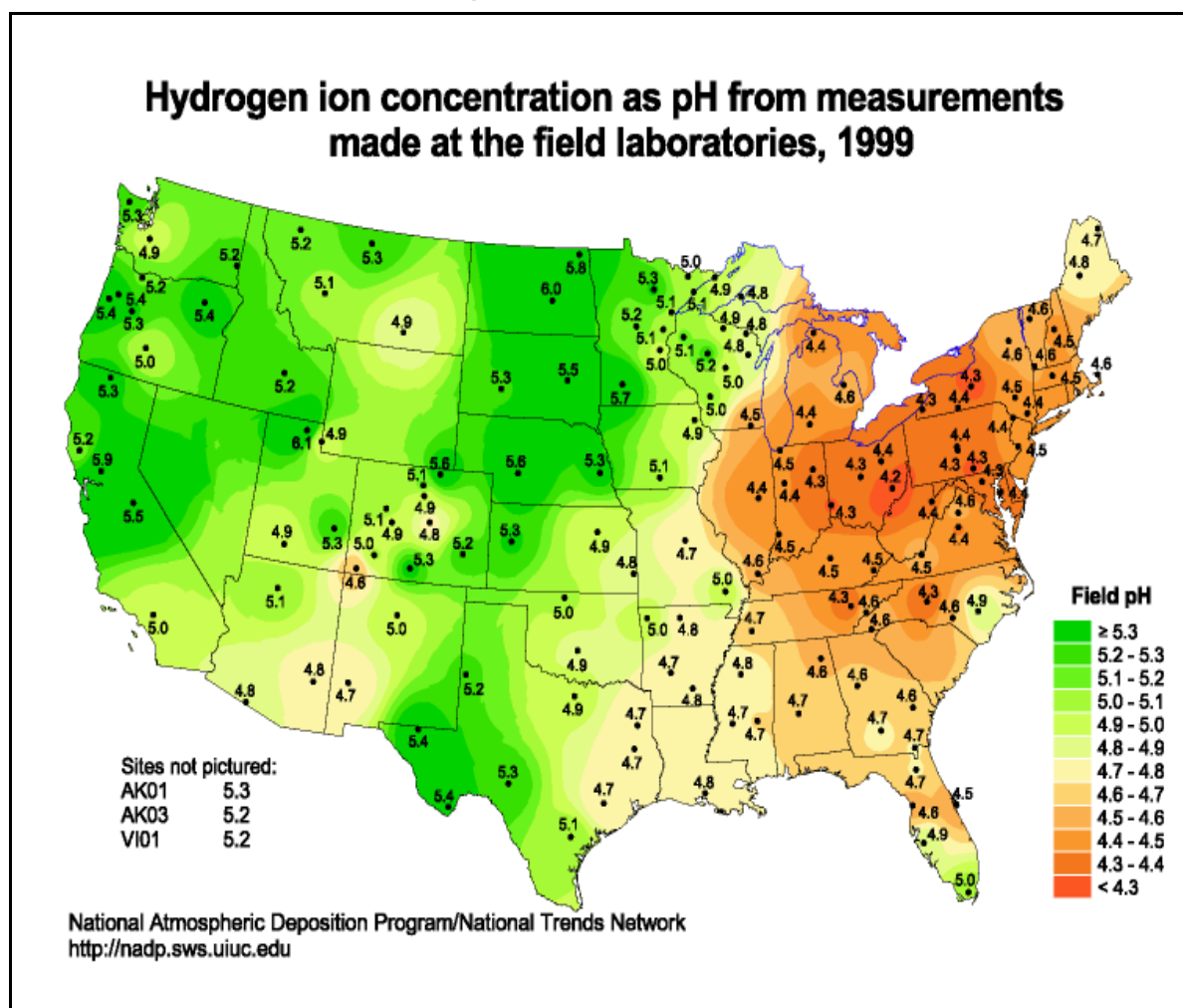
⁶ State and Territorial Air Pollution Program Administrators (STAPPA) and the Association of Local Air Pollution Control Officials (ALAPCO), *Reducing Greenhouse Gases & Air Pollution: A Menu of Harmonized Options*, October 1999, p. 288. See <http://www.4cleanair.org>

2. ACID RAIN AND ACID DEPOSITION

2.1. Characterization of the Problem

Acid rain – or more generally and accurately, acidic deposition – occurs when emissions of SO_2 and NO_x react in the atmosphere with water, oxygen, and oxidants to form various acidic compounds including sulfuric acid and nitric acid. These compounds then fall to earth either as “wet deposition” (i.e., in rain, snow, or fog) or “dry deposition” (e.g., as fine soot particles). Figure 2-1 illustrates that acid deposition levels in the Northeast are among the highest in the nation (i.e., pH values – reflecting hydrogen ion concentrations – are among the lowest).

FIGURE 2-1. Acid Deposition Levels in the United States



Source: US EPA

New Hampshire has the longest continuous record of precipitation chemistry monitoring in North America at the Hubbard Brook Experimental Forest (HBEF) station in Woodstock

where precipitation monitoring began in 1963. In addition, DES has been monitoring precipitation pH since 1972. During this extended period, annual median precipitation on New Hampshire watersheds has been at pH values below 4.5 – a figure over 20 times more acidic than unpolluted precipitation. In addition, pH readings below 3.0 have been observed in individual storm events, and pH values below 4.0 for storm events are not unusual.

2.1.1. Acid Rain Status of New Hampshire Lakes

New Hampshire lakes are extremely vulnerable to acid deposition because they are poorly buffered to counteract the effects of acid inputs. The buffering capacity of a lake is its ability to neutralize acid inputs without becoming more acidic. This capacity is determined primarily by the amount of calcium carbonate or other carbonates (e.g., limestone) in the system. New Hampshire's granite bedrock contributes few of these carbonate minerals to surface waters. Acid Neutralizing Capacity (ANC) is a measure of the buffering capacity of waters. An ANC of 10 or less is generally accepted as the level that denotes high sensitivity to acid rain. Table 2-1 indicates that fully 85 percent of the state's lakes and 95 percent of the remote – mostly high-elevation – ponds fall into this high sensitivity category.

An ANC value of zero or less denotes an acidified lake; acidified lakes are unlikely to support a naturally reproducing population of fish. Approximately 20 of the State's lakes are acidified, as are six of the State's remote ponds.

TABLE 2-1. Acid Neutralizing Capacity (ANC) of NH Lakes and Remote Ponds

| New Hampshire Lake Surveys | | | | | | Remote Ponds | |
|----------------------------|------------|--------|------|--------|------|--------------|------|
| Sensitivity Category | ANC (mg/L) | Summer | | Winter | | Spring | |
| | | No. | % | No. | % | No. | % |
| Acidified | ≤ 0 | 21 | 3 | 19 | 3 | 6 | 10 |
| Critical | > 0-2 | 134 | 18 | 141 | 19 | 26 | 46 |
| Endangered | > 2-5 | 244 | 32 | 237 | 32 | 15 | 26 |
| Highly sensitive | > 5-10 | 228 | 30 | 224 | 31 | 8 | 14 |
| Sensitive | > 10-20 | 98 | 13 | 80 | 11 | 2 | 4 |
| Not sensitive | > 20 | 31 | 4 | 32 | 4 | 0 | 0 |
| <i>Total</i> | | 756 | 100% | 733 | 100% | 57 | 100% |

Source: DES

Table 2-2, which summarizes the pH level (i.e., acidity) of New Hampshire lakes and ponds, also reveals a significant difference between summer and winter acid status. During the summertime, the pH of waters may be artificially elevated due to photosynthesis. As a result, winter pH data is a better indicator of the pH that aquatic organisms are exposed to during the year. Table 2-2 shows that 20 percent of the state's lakes in the summer – but fully 55 percent in the winter – have pH values of 6 or less. Remote ponds sampled in the spring – even after the worst-case snowmelt period – indicate that over 70 percent are endangered or worse.

While pH readings can thus vary as a function of when samples are collected, lakes are considered acidified when their pH value drops below 5.0. According to this measure,

approximately 2-3 percent of all New Hampshire lakes and 10 percent of the remote ponds are acidified. These lakes probably do not support most species of fish.

TABLE 2-2. Acidity (pH Level) of New Hampshire Lakes and Ponds

| Sensitivity Category | pH (units) | New Hampshire Lake Surveys | | Remote Ponds | | | |
|----------------------|------------|----------------------------|-----|--------------|------|------------|------|
| | | Summer No. | % | Winter No. | % | Spring No. | % |
| Acidified | < 5 | 18 | 2 | 22 | 3 | 6 | 10 |
| Critical | 5.0 – 5.4 | 33 | 4 | 80 | 11 | 10 | 17 |
| Endangered | 5.5 – 6.0 | 93 | 12 | 227 | 32 | 26 | 45 |
| Satisfactory | > 6 | 611 | 81 | 389 | 54 | 16 | 28 |
| <i>Total</i> | | 755 | 99% | 718 | 100% | 58 | 100% |

Source: DES

New Hampshire's acidified lakes and remote ponds, based on ANC and pH level, are listed by name and location in Table 2-3. As this table shows, all areas of New Hampshire have acidified waterbodies, indicating that (1) this problem is due to a combination of in-state and out-of-state pollution, and (2) certain waterbodies are more vulnerable than others.

TABLE 2-3. Acidified Lakes and Remote Ponds in New Hampshire

| Lake | Location | ANC | pH |
|---------------------|--------------|------|-----|
| Baker Pond | Chesterfield | 0.0 | 5.2 |
| Barrett Pond | Washington | 0.0 | 5.3 |
| Bear Hill Pond | Allenstown | -1.3 | 4.5 |
| Bowker Pond | Fitzwilliam | -0.3 | 4.8 |
| Brackett Pond | Wentworth | -0.8 | 4.7 |
| Cone Pond | Thornton | -1.0 | 4.7 |
| Constance Lake | Piermont | -0.2 | 4.9 |
| Darrah Pond | Litchfield | -1.3 | 4.5 |
| Divol Pond | Rindge | -1.2 | 4.6 |
| Four Mile Pond | Dix's Grant | -0.2 | 5.1 |
| Gordon Pond | Lincoln | -0.8 | 4.6 |
| Kilburn Pond | Winchester | -1.3 | 4.5 |
| Kinsman Pond | Lincoln | -1.9 | 4.5 |
| Lily Pond | Alstead | -0.2 | 5.0 |
| Long Pond | Lempster | -0.1 | 5.3 |
| Loon Pond | Lincoln | -1.0 | 4.8 |
| Lovewell Pond | Nashua | -3.0 | 4.3 |
| Nancy Pond | Livermore | -0.8 | 4.7 |
| Pisgah Reservoir | Winchester | 0.0 | 4.4 |
| Signal Pond | Errol | -0.6 | 4.9 |
| Solitude, Lake | Newbury | -0.3 | 4.9 |
| Spruce Pond | Deerfield | -0.3 | 4.8 |
| Willey Pond, Big | Strafford | -0.7 | 4.7 |
| Willey Pond, Little | Strafford | -1.0 | 4.6 |
| Winkley Pond | Barrington | -0.2 | 5.1 |

Source: DES

Table 2-4, developed by EPA's National Acid Precipitation Assessment Program (NAPAP), lists some of the biological effects that occur in aquatic ecosystems as the pH declines (i.e., as acidity increases).

TABLE 2-4. General Biological Effects of Decreasing pH (Increasing Acidity)

| pH Decline | Resulting Biological Effects |
|------------|---|
| 6.5 to 6.0 | <ul style="list-style-type: none"> • Small decrease in species richness of plankton and benthic invertebrate communities resulting from the loss of a few highly acid-sensitive species, but no measurable change in total community abundance or production. • Some adverse effects (decreased reproductive success) may occur for highly acid-sensitive fish species (e.g., fathead minnow, striped bass). |
| 6.0 to 5.5 | <ul style="list-style-type: none"> • Loss of sensitive species of minnows and dace, such as fathead minnow and blacknose dace; in some waters, decreased reproductive success of lake trout and walleye, which are important sport fish species in some areas. • Visual accumulations of filamentous green algae in the near-shore zone of many lakes and in some streams. • Distinct decrease in species richness and change in species composition of plankton and benthic invertebrate communities, although little if any change in total community abundance or production. • Loss of some common invertebrate species from zooplankton and benthic communities, including many species of snails, clams, mayflies, and amphipods, and some crayfish. |
| 5.5 to 5.0 | <ul style="list-style-type: none"> • Loss of several important sport fish species, including lake trout, walleye, rainbow trout, and smallmouth bass, as well as additional nongame species such as creek chub. • Further increase in the extent and abundance of filamentous green algae in lake near-shore areas and streams. • Continued shift in species composition and decline in species richness of plankton, periphyton, and benthic invertebrate communities; decreases in total abundance and biomass of benthic invertebrates and zooplankton may occur in some waters. • Loss of several additional invertebrate species common in surface waters, including all snails, most species of clams, and many species of mayflies, stoneflies, and other benthic invertebrates. • Inhibition of nitrification. |
| 5.0 to 4.5 | <ul style="list-style-type: none"> • Loss of most fish species, including most important sport fish species such as brook trout and Atlantic salmon. A few fish species are able to survive and reproduce in water below pH 4.5 (e.g., central mudminnow, yellow perch, and in some waters, largemouth bass). • Measurable decline in the whole-system rates of decomposition of some forms of organic matter, potentially resulting in decreased rates of nutrient cycling. • Substantial decrease in number of species of plankton and benthic invertebrates and further decline in species richness of plankton and periphyton communities: measurable decrease in total community biomass of plankton and benthic invertebrates in most waters. • Loss of additional species of plankton and benthic invertebrate species, all clams, many insects and crustaceans. • Reproductive failure of some acid-sensitive species of amphibians, such as spotted salamanders, Jefferson salamanders, and the leopard frog. |

Source: US EPA

Although some minor changes may occur between pH 6.5 to 6.0, Table 2-3 shows that significant adverse impacts to important aquatic food chain organisms begin to occur as pH drops below 6.0.

2.1.2. Acid Rain Trends in New Hampshire Lakes

DES has been monitoring acid rain trends in approximately 25 remote, high-elevation ponds during the spring each year, and in 20 lower-elevation accessible headwater ponds during spring and fall overturn each year, since 1982 and 1983 respectively. In general, there was no trend in pH for either set of lakes during this time period. For ANC, the remote ponds

also showed no trend for the period of record. For the accessible ponds, however, the period of trend analysis was important. During the first ten years, approximately three-fourths showed an increasing (positive) trend in ANC, while none showed an increasing trend over the last ten years. Approximately one-half showed an increasing trend for the entire 17-year period.

This New Hampshire observation is not unique. A study looking at trends in recovery in both North America and Europe also observed a difference in trends between the 1980s and 1990s.⁷ The lack of any increase in ANC in the remote ponds is also not unique to New Hampshire. These ponds appear to be similar to the Adirondack lakes that also have shown no improvement in ANC. The absence of improvement is important, because over the last decade, sulfur dioxide emissions have decreased, sulfate deposition has decreased, and sulfate concentrations in surface water have decreased – and yet the expected increase in ANC has not occurred. This may be partially due to NO_x emissions that have changed little over the period (and some lakes have shown increases in nitrate, apparently because of a reduction in the capacity of vegetation within the watershed to use nitrogen). However, the lack of ANC recovery is probably due primarily to the reduction in base cations, such as calcium and magnesium, from the water. The fact that large quantities of calcium and magnesium have been lost from the soil and exported out of the ecosystem because of acid rain means that the recovery of surface waters will be delayed significantly and that more reductions in SO₂ and NO_x emissions are needed. Scientific models suggest that the greater the cuts in emissions, the sooner the environment can recover.

The effects of acid deposition can be especially harmful in the spring when the winter snow pack melts. The ecosystem is shocked with a large volume of water carrying several months' accumulation of deposited inorganic acids and toxic metals like mercury. Further, this toxic shock occurs during the critical first phases of the annual reproductive cycles of plants, animals, and fish. The New Hampshire Fish and Game Department stocks a number of remote ponds with brook trout after the spring snowmelt. Many of these ponds would probably not support a naturally reproducing brook trout population because of the exposure of the developing embryos to the springtime acid shock. In fact, some ponds are no longer stocked by the New Hampshire Fish and Game Department because of poor fish survival or poor returns (e.g., Cone Pond in Thornton, Carrigain Pond in Lincoln, and Constance Lake in Piermont).

2.1.3. Other Impacts of Acid Deposition and Acid Aerosols

In addition to aquatic ecosystems, acid deposition also affects terrestrial ecosystems, human health, visibility, and buildings and historical monuments. Research conducted at Hubbard Brook and at other areas in the region has demonstrated that overall forest productivity is reduced and die-offs of sensitive species such as red spruce have occurred as a result of acid rain. The mechanism of impact includes both the leaching of essential forest nutrients from the soil, such as calcium and magnesium, which leaves the trees more vulnerable to cold and

⁷ Stoddard et al., *Regional Trends in Aquatic Recovery from Acidification in North America and Europe*, Nature, 1999, 404: 575-578.

insects, and the conversion of soil aluminum to a toxic form that hampers root development⁸ Recent analyses⁹ conducted at the Hubbard Brook Experimental Forest in Woodstock, New Hampshire and at the University of New Hampshire appear to indicate that:

- The ecological impacts of inorganic acid deposition are far greater than those of naturally occurring organic acidity;
- Inorganic acidification leaches calcium – a key building block in cell walls – from the soil, which appears to retard tree growth and diminish forest productivity; and
- Inorganic aluminum ions that are toxic to freshwater fish are made more bio-available by inorganic acidification.

In 1997, the New Hampshire Comparative Risk Project¹⁰ ranked degradation of surface water habitat as the highest environmental risk for New Hampshire. In addition, acid deposition was ranked sixth highest. Excessive nitrate concentrations are harmful in drinking water supplies – particularly to children – and were also included.

The human health effects of SO₂ and NO_x are well documented. SO₂ combines with water vapor to form acidic aerosols harmful to the respiratory tract, and aggravates symptoms associated with respiratory diseases such as asthma and chronic bronchitis, in some cases leading to premature death. NO_x also has been shown to lower resistance to respiratory infections and to increase respiratory illnesses in children. NO_x is also the key ingredient responsible for forming ground level ozone, the human health effects of which are discussed in Chapter 4. Research conducted on hikers in the White Mountains by the Appalachian Mountain Club (AMC) and others has demonstrated that low-level exposure to ozone, fine particulate matter, and strong aerosol acidity during prolonged outdoor exercise has a significant adverse impact on pulmonary functioning in adults, with greater impacts occurring to hikers with asthma.¹¹

AMC has also demonstrated a strong association between haze and visibility and the concentration of acid aerosols in the Great Gulf and Presidential-Dry River Wilderness Area airsheds in New Hampshire.¹²

2.2. Existing Programs and Commitments

Emissions of SO₂, the primary acid rain precursor, are currently regulated under two programs: the New Hampshire Acid Deposition Control Program (NH RSA 125-D) and the federal Acid Rain Program (Title IV of the 1990 Clean Air Act Amendments).

Acid rain has been a major concern in New Hampshire for many years. So much so that the New Hampshire Acid Deposition Control Program (New Hampshire Code of Administrative

⁸ U.S. Environmental Protection Agency, Office of Water, *Air Pollution and Water Quality, Atmospheric Deposition Initiative*, 2000. See <http://www.epa.gov/OWOW/oceans/airdep/air3.html>

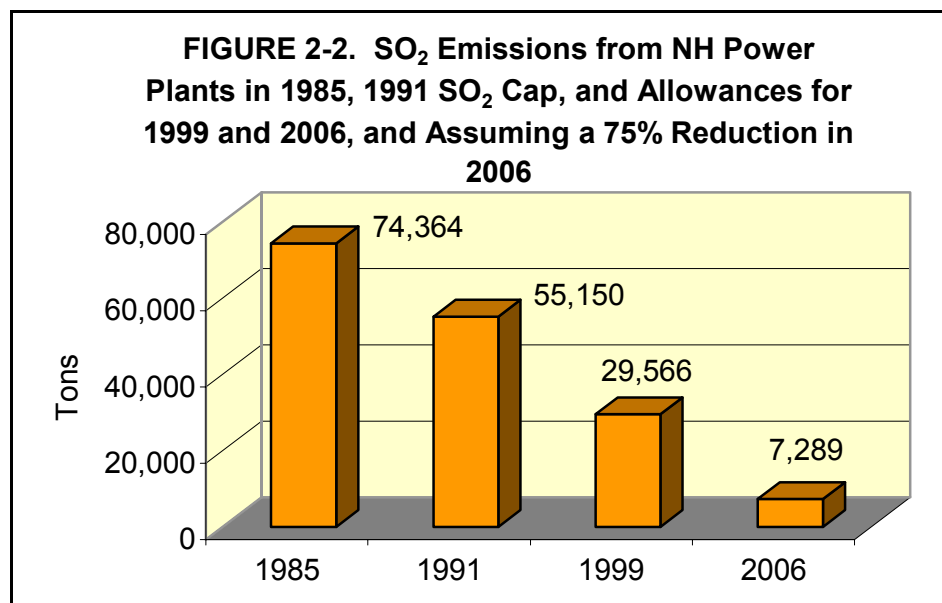
⁹ See for example, the Hubbard Brook Ecosystem Study. See <http://www.hbrook.sr.unh.edu>

¹⁰ New Hampshire Comparative Risk Project, *Report of Ranked Environmental Risks in New Hampshire, 1 May 1997*. See http://www.scorecard.org/comp-risk/report.tcl?fips_state_code=33

¹¹ Korrick, et al., *Effects of Ozone and Other Pollutants on the Pulmonary Function of Adult Hikers*, *Environmental Health Perspectives*, 106:93, 1998.

¹² Hill, et al. *Characterization of Acid Aerosols and Regional Haze-Related Visibility Impairment, Great Gulf and Presidential-Dry River Class-I Wilderness Airsheds, New Hampshire*, 1996.

Rules Chapter Env-A 400) was adopted in 1991, four years before Phase I of the federal Acid Rain Program. Env-A 400 established an annual SO₂ tonnage cap (55,150 tons) for all existing power plant boilers in New Hampshire. This cap achieved a 25 percent reduction from 1985 baseline emissions (see Figure 2-2). New Hampshire is the only State that adopted an independent, statewide, annual SO₂ tonnage cap on all existing power plant boilers.



Source: US EPA and DES

The federal Acid Rain Program required a two-phased tightening of the restrictions placed on power plants. Phase I, which began in 1995, affected only the largest and highest-emitting coal-burning plant in New Hampshire, Merrimack Station. Phase II, which began in 2000, tightened the annual SO₂ tonnage cap and broadened its applicability (from 31,343 tons at Merrimack Station alone to 29,566 tons applicable to all the existing large power plant boilers in New Hampshire). Subject facilities are required to hold allowances to cover each ton of SO₂ emissions emitted during the year, and they can buy and sell allowances to achieve this. Both of the new gas-fired power plants under construction in New Hampshire are also subject to federal and state acid rain regulations.

2.3. Reasons for Further Action

Despite the significant SO₂ reductions that have been achieved under the federal and state Acid Rain programs,¹³ recent evidence indicates that Northeastern ecosystems are recovering from acid deposition much more slowly than anticipated.¹⁴ At pH readings as low as 2.5, scientists in New Hampshire's White Mountains still see rainfall that is as acidic as lemon

¹³ United States General Accounting Office. *Acid Rain: Emissions Trends and Effects in the Eastern United States* (Letter Report, 03/09/2000, GAO/RCED-00-47). See http://www.access.gpo.gov/su_docs/aces/aces160.shtml

¹⁴ The Hubbard Brook Research Foundation, *Hubbard Brook Ecosystem Study*, 2000. See <http://www.hbrook.sr.unh.edu>

juice or vinegar (e.g., pH of 2-3).¹⁵ One analysis concluded that the federal Acid Rain Program “has reduced emissions and may prevent future damage, but emission reductions do not appear to be sufficient to restore lakes in the Adirondacks and elsewhere that are highly acidified.”¹⁶

The U.S. General Accounting Office appears to agree with this assessment:

On the basis of our review of relevant scientific literature, it appears that the vegetation and land surrounding these lakes have lost some of their previous capacity to use nitrogen, which allowed more of the nitrogen to flow into the lakes and increase their acidity. Increases in these lakes’ acidity raise questions about their prospects for recovering under the current program and being able to support fish and other wildlife.¹⁷

As a result, among their other pollution reduction efforts, several Northeast states – including New Hampshire – have petitioned EPA to set secondary National Ambient Air Quality Standards (NAAQS) for NO₂, SO₂, ozone and fine particulate matter. “Secondary NAAQS” under the Clean Air Act are designed to be protective of welfare (e.g., visibility, economic well-being, etc.) and the environment. “Primary NAAQS” are protective of human health.

In June 1997, the New England Governors’ Conference and Eastern Canadian Premiers (NEGC/ECP) recognized that acid deposition continues to be a concern for which a regional approach on research and strategic action is required, and charged its Committee on the Environment to present specific recommendations at its next meeting. The resulting NEGC/ECP Acid Rain Action Plan was approved at the June 1998 meeting, which was chaired by New Hampshire Governor Jeanne Shaheen. This Action Plan identified several steps to address acid rain including:

- A comprehensive and coordinated plan for further reducing SO₂ and NO_x emissions, which contribute to the problem of long range transport of air pollutants, acid deposition, and nutrient enrichment of marine waters in the region;
- A recommendation to reduce annual SO₂ emissions by 50 percent more than then-current commitments by the year 2010;
- A recommendation to reduce annual NO_x emissions by 20–30 percent more than then-current commitments by the year 2007;
- A research and monitoring agenda targeted at improving the state-of-the-science regarding acid deposition and increasing regional cooperation in sharing research and data in order to better understand the impact of acid deposition on the region and to analyze the effectiveness of current control programs on sensitive ecosystems; and
- A public education and outreach agenda to ensure that the public continues to be educated and mobilized towards the overall goal of protecting the natural environment.

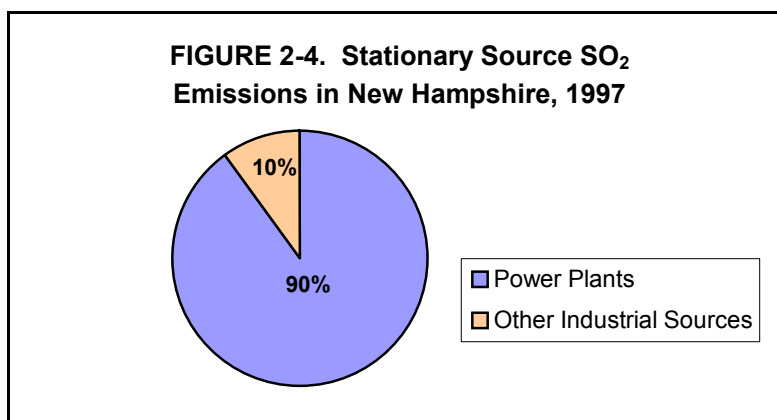
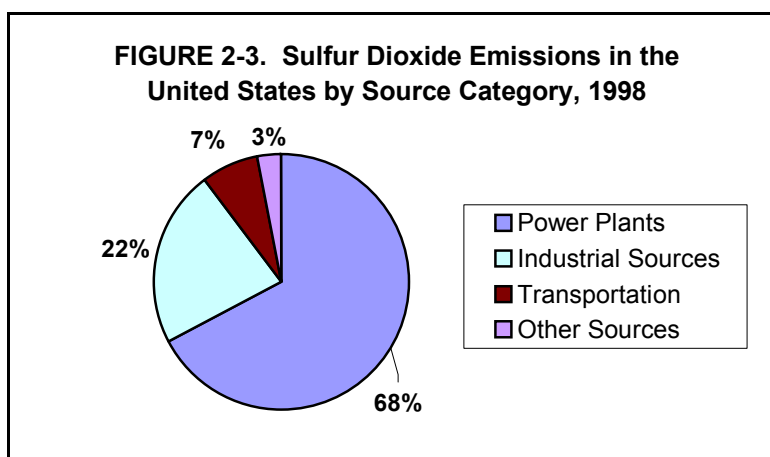
¹⁵ Hill, L. Bruce, Clean Air Task Force (formerly Appalachian Mountain Club), personal communication, December 14, 2000.

¹⁶ Bryner, Gary C., *New Tools for Improving Government Regulation: An Assessment of Emissions Trading and Other Market-Based Regulatory Tools*, Natural Resources Law Center, University of Colorado School of Law, October 1999.

¹⁷ United States General Accounting Office. *Acid Rain: Emissions Trends and Effects in the Eastern United States*, Letter Report, March 9, 2000, GAO/RCED-00-47.

The recommendations contained in the NHCPS will help New Hampshire implement the NEGCEP Acid Rain Action Plan and achieve its goals. In further pursuit of acid rain reductions, New Hampshire has joined in litigation against certain Midwest power plants that may have increased their SO₂ and NO_x emissions illegally, and in litigation to uphold federal requirements to reduce regional haze.

Power plants that burn coal or oil are the predominant source of SO₂ emissions (see Figure 2-3), and are a large source of NO_x emissions. In 1997, coal- and oil-burning power plants were responsible for 90 percent of the SO₂ emissions from stationary sources in New Hampshire (see Figure 2-4). The average annual SO₂ emission rate from New Hampshire's coal- and oil-burning power plants in 1999 – in full compliance with existing federal and state regulations – was approximately 22.92 lbs/MWh. By contrast, the average annual SO₂ emission rate for new, combined cycle power plants burning natural gas is just 0.01 lbs/MWh, over 2,000 times cleaner. Under federal New Source Performance Standards (NSPS), new coal plants are required to meet an SO₂ emission rate limit of 0.3 lbs/mmBtu, which is approximately equivalent to 3.0 lbs/MWh.



Substantial additional SO₂ and NO_x reductions – beyond existing programs and commitments – are clearly necessary to restore and improve New Hampshire’s lakes and ponds and to increase the productivity of the State’s forests. These reductions will provide multiple additional benefits as well, including human health gains through less particulate matter formation (see Chapter 3), less ground level ozone (see Chapter 4), enhanced ecosystem integrity, less eutrophication and nitrification of waterbodies (see Chapter 6), better visibility and improvement in scenic quality (see Chapter 8), and the attendant economic benefits to recreational and natural resource industries (see Chapter 12). These reductions in air pollution will also help level the competitive playing field between “grandfathered” power plants and new facilities, as called for in New Hampshire RSA 374-F:3,VIII.

Additionally, measures to reduce SO₂ and NO_x emissions typically result in simultaneous “co-benefit” reductions in other pollutants, such as mercury (see Chapter 5) and other toxic contaminants (see Chapter 9), and carbon dioxide (see Chapter 7). Energy efficiency measures – which avoid having to generate electricity in the first place – are among the most effective means of reducing air pollution, since they avoid all emissions of all pollutants, and simultaneously save users the money they would have spent to buy the electricity.

The NHCPS seeks to provide New Hampshire citizens with the benefits of reduced acid deposition by recommending a 75 percent further reduction in annual SO₂ emissions beyond current levels, implemented using market-based measures and an emissions cap based on 3.0 lbs/MWh, and a 70 percent further reduction in annual NO_x emissions beyond current levels, implemented using market-based measures and an emissions cap based on 1.5 lbs/MWh, applicable to New Hampshire’s existing coal- and oil-burning power plants. The NHCPS recommends that these reduction requirements for SO₂ and NO_x take effect in 2006. Several of DES’s efforts in pursuit of similar SO₂ and NO_x reductions from other emission sources are described in Chapter 10.

3. FINE PARTICULATE MATTER (PM_{2.5})

3.1. Characterization of the Problem

The term “particulate matter” encompasses a wide variety of tiny solid particles found in the air. Particles smaller than 2.5 microns (millions of a meter) in diameter are referred to as “fine particulate matter” or PM_{2.5}. While some particulate matter occurs naturally (e.g., crustal dust), fine particulate matter typically results from fossil fuel combustion by power plants, motor vehicles, and industrial, commercial, and residential facilities, including wood burning. Fine particles are also formed in the atmosphere from such gases as SO₂, NO_x, and volatile organic compounds (VOCs) in a process referred to as “secondary formation.”

The human health effects of PM_{2.5} and its precursor emissions, SO₂ and NO_x, are well documented. SO₂ combines with water vapor to form acidic aerosols harmful to the respiratory tract, and aggravates symptoms associated with respiratory diseases such as asthma and chronic bronchitis, in some cases leading to premature death. NO_x is also known to aggravate symptoms associated with asthma and bronchitis, and has been shown to lower resistance to respiratory infections and to increase respiratory illnesses in children. NO_x is also the key ingredient responsible for forming ground level ozone, the human health effects of which are discussed in Chapter 4.

PM_{2.5} is a significant public health concern because it is inhaled into the deepest recesses of the lungs, where it can exacerbate or trigger pulmonary afflictions. One recent analysis, commissioned by Clear the Air and the Clean Air Task Force and conducted by Abt Associates using EPA methodologies, estimated that 67 premature deaths and 1,540 asthma attacks occur annually in New Hampshire due to PM_{2.5} from the nation’s coal-burning power plants.¹⁸ Similarly, two studies commissioned by the Health Effects Institute (HEI) were recently published. The first study, which appeared in *The New England Journal of Medicine* on December 14, 2000, correlated fine particulate air pollution and mortality in twenty U.S. cities from 1987 through 1994. This assessment used PM₁₀ (which includes PM_{2.5}), and showed that for each 10 microgram per cubic meter increase in the amount of particulates in the air, almost seven more people per one thousand (0.68 percent) die due to cardiovascular and respiratory causes, and over five more people per one thousand (0.51 percent) die from all causes put together.¹⁹ A second study was conducted by scientists at the National Research Center for Environment and Health in Neuherberg, Germany. This effort, which employed time series to measure correlations between daily changes in particulate pollution and mortality, also found that high concentrations of fine particles and “ultrafine” particles were consistently associated with mortality.²⁰

¹⁸ Abt Associates, Clear The Air’s National Campaign Against Dirty Power, *Health Impacts Analysis*, October 17, 2000. See <http://www.cleartheair.org>

¹⁹ Samet, Johnathan M., et al., *Fine Particulate Air Pollution and Mortality in 20 U.S. Cities, 1987-1994*, New England Journal of Medicine, December 14, 2000. See <http://www.nejm.org/content/2000/0343/0024/1742.asp>

²⁰ Wichmann, Dr. H-Erich, et al., *Daily Mortality and Ultrafine Particles in Erfurt, Germany, Part I*, November 2000. See <http://www.healtheffects.org>

Scientific studies have also linked fine particulate matter to a series of other health problems including aggravated asthma, acute respiratory symptoms, chronic bronchitis, and decreased lung function. Children, the elderly, individuals with pre-existing heart or lung disease, and asthmatics are most at risk from exposure to fine particles. Determining the specific toxicological pathways that create these impacts requires further research, but the epidemiological linkage is clear. EPA is sufficiently concerned about the health effects of PM_{2.5} that it has adopted a new, much more stringent NAAQS for this pollutant. Unfortunately, its implementation has been delayed by litigation.

3.2. Existing Programs and Commitments

New Hampshire currently has no emission control program specifically addressing PM_{2.5}. Since SO₂ is the primary precursor of PM_{2.5} in the eastern United States, however, New Hampshire's existing SO₂ control programs provide some progress in this direction.

In July 1997, EPA promulgated new National Ambient Air Quality Standards (NAAQS) for PM_{2.5} based upon this pollutant's significant health impacts as demonstrated in several scientific studies. Two PM_{2.5} NAAQS were set, a limit of 65 micrograms per cubic meter averaged over a 24-hour period, and 15 micrograms per cubic meter as an annual average. (The old PM₁₀ standard was retained, at 150 micrograms per cubic meter for 24 hours and 50 micrograms per cubic meter as an annual average). The new NAAQS were litigated by several industries and Midwestern states, and in May 1999, the US Court of Appeals for the District of Columbia issued a ruling on the PM_{2.5} standard as promulgated by EPA. The court stated that since PM_{2.5} does not have a specific "threshold" for the presence or absence of health effects, EPA needed to articulate clearer criteria for choosing the level that it did set. The court also ruled that the coarse particulate matter or PM₁₀ standard needed to be distinct from any PM_{2.5} standard.

In May 2000, the United States Supreme Court agreed to review the Appeals Court's decision, and it heard oral arguments on November 7, 2000. New Hampshire, along with other Northeast states, supports the proposed PM_{2.5} standard and will continue to move forward to reduce the emissions that cause fine particulate pollution. PM_{2.5} has historically been monitored at two sites in the Mount Washington area. Construction of a more extensive, statewide monitoring network for PM_{2.5} was begun in 1998. The PM_{2.5} attainment status for New Hampshire will be determined in the 2004-2005 timeframe, after at least three years of reliable monitoring data is collected.

3.3. Reasons for Further Action

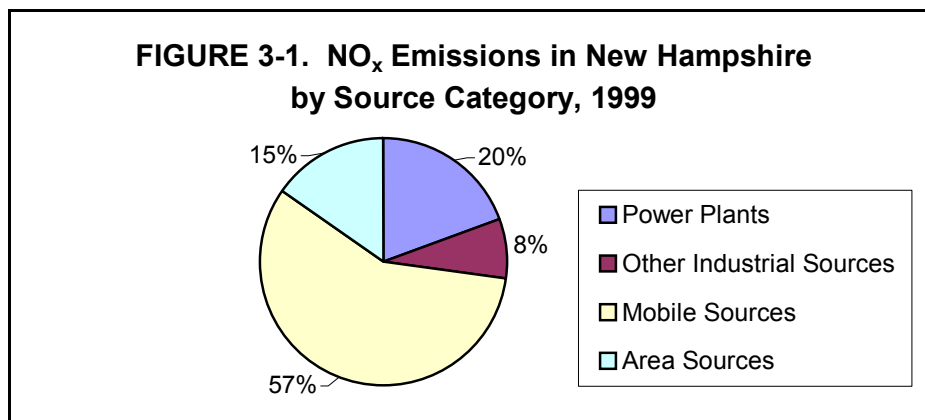
The Abt Associates study referenced above concluded that a 75 percent reduction in power plant pollution would avoid 45 of the estimated 67 premature deaths, and over 1,000 of the estimated 1,540 asthma attacks, that occur annually in New Hampshire.²¹ In 1997, the New Hampshire Comparative Risk Project²² ranked airborne particulate matter as the second

²¹ Abt Associates, Clear The Air's National Campaign Against Dirty Power, *Health Impacts Analysis*, October 17, 2000. See <http://www.cleartheair.org>

²² New Hampshire Comparative Risk Project, *Report of Ranked Environmental Risks in New Hampshire*, 1 May 1997. See http://www.scorecard.org/comp-risk/report.tcl?fips_state_code=33

highest environmental risk for New Hampshire. Research conducted on hikers in the White Mountains by the Appalachian Mountain Club (AMC) and others has demonstrated that low-level exposure to fine particulate matter, ozone, and strong aerosol acidity during prolonged outdoor exercise has a significant adverse impact on pulmonary functioning in adults, with greater impacts occurring to hikers with asthma.²³ AMC has also demonstrated a strong association between haze and visibility and the concentration of acid aerosols in the Great Gulf and Presidential-Dry River Wilderness Area airsheds in New Hampshire.²⁴

In the Northeast, SO₂ is principally responsible for the formation of fine particulate matter in the atmosphere; NO_x contributes to secondary particulate formation to a much lesser degree. Due to the fact that PM_{2.5} is a “zero-threshold” pollutant (i.e., it has deleterious health effects all the way down to zero concentration), and due to the inability of existing programs and commitments to adequately protect public health and the environment from the risks enumerated above, substantial additional reductions in SO₂ and NO_x emissions are necessary to reduce the risks associated with PM_{2.5}. Since power plants that burn coal or oil are the predominant source of SO₂ emissions (see Figure 2-3) and are a large source of NO_x emissions (see Figure 3-1), the NHCPS recommends stringent SO₂ and NO_x caps to indirectly reduce PM_{2.5} concentrations.



Source: DES

Such reductions will provide multiple additional benefits as well, including direct improvement in human health, less acid deposition (see Chapter 2), less ground level ozone (see Chapter 4), less eutrophication and nitrification of waterbodies (see Chapter 6), nitrate concentrations in drinking water that are harmful to children, better visibility and enhanced scenic quality (see Chapter 8), and the attendant economic benefits to recreational and natural resource industries (see Chapter 12). They will also help level the competitive playing field between “grandfathered” power plants and new facilities, as called for in New Hampshire RSA 374-F:3, VIII.

In addition, measures to reduce PM_{2.5} concentrations through SO₂ and NO_x emission reductions typically result in simultaneous “co-benefit” reductions in other pollutants, such as

²³ Korrick, et al., *Effects of Ozone and Other Pollutants on the Pulmonary Function of Adult Hikers*, Environmental Health Perspectives, 106:93, 1998.

²⁴ Hill, et al. *Characterization of Acid Aerosols and Regional Haze-Related Visibility Impairment, Great Gulf and Presidential-Dry River Class-I Wilderness Airsheds, New Hampshire*, 1996.

mercury (see Chapter 5), other toxic contaminants (see Chapter 9), and carbon dioxide (see Chapter 7). Energy efficiency measures – which avoid having to generate electricity in the first place – are among the most effective means of reducing air pollution, since they avoid all emissions of all pollutants, and simultaneously save users the money they would have spent to buy the electricity.

The NHCPS seeks to provide New Hampshire citizens with the PM_{2.5} reduction benefits enumerated above by recommending a 75 percent further reduction in annual SO₂ emissions beyond current levels, implemented through an emissions cap based on 3.0 lbs/MWh, and a 70 percent further reduction in annual NO_x emissions beyond current levels, implemented using market-based measures and an emissions cap based on 1.5 lbs/MWh, applicable to New Hampshire's existing coal- and oil-burning power plants. The NHCPS recommends that these reduction requirements for SO₂ and NO_x take effect in 2006. Several of DES's efforts in pursuit of similar SO₂ and NO_x reductions from other emission sources are described in Chapter 10.

4. GROUND LEVEL OZONE OR “SMOG”

4.1. Characterization of the Problem

Ground level ozone or “smog” is formed by a chemical reaction between NO_x and VOCs in the presence of heat and sunlight. Ground level ozone causes serious respiratory problems, especially in populations that are already under stress, including the very young, elders, and those with respiratory illnesses such as asthma. Even people outside of these high risk groups are subject to symptoms such as headaches, sore throats, coughing, and shortness of breath.²⁵ The health effects of ground level ozone are also evident in increased hospital admissions and emergency room visits during periods of elevated ozone concentrations.

Results of the 1999 Children’s Health Study, conducted by investigators at the University of Southern California and the California Air Resources Board (CARB), indicate that children with a prior diagnosis of asthma are more likely to develop persistent lower respiratory tract symptoms when exposed to air pollution.²⁶ Ozone has long been known to cause temporary decreases in lung capacity and inflammation of lung tissue. Recent research among children in California, however, appears to suggest that lung function may be permanently reduced with each year of exposure to elevated ozone levels.²⁷ Further, the inhalation of ozone can impair the body’s immune system, and many individuals consume anti-oxidants such as vitamin E as a regular dietary supplement in order to combat the effects of potent oxidants like ozone.

Because of these dangers, each summer DES and the Department of Health and Human Services, in conjunction with the American Lung Association and the EPA, carefully monitor daily ozone concentrations. When ambient ozone concentrations are expected to approach or exceed unhealthy levels, air quality alerts are issued to the news media, posted on the internet, and made available via an “800” telephone number. These alerts warn people with respiratory problems to stay indoors and avoid exercise. It is unfortunate that on some of the warmest, sunniest days of the summer, we have to tell many visitors and residents to avoid being outside enjoying our beautiful state because of these ozone episodes. Because all people are advised to limit or forgo outdoor activities and exertion during these episodes, quality of life is reduced for everyone subject to elevated ozone concentrations.

In the environment, ground-level ozone interferes with the ability of all plants – including agricultural crops – to produce and store food. As a result, ground level ozone compromises plant growth and reproduction, makes plants more susceptible to disease and pests, and reduces agricultural and forest yields. This fact is illustrated in Figure 4-1, which shows the negative correlation between average ozone concentrations and the average “red edge inflection point” (REIP) as measured by the University of New Hampshire’s (UNH) Forest

²⁵ U.S. Environmental Protection Agency, Office of Water, *Air Pollution and Water Quality, Atmospheric Deposition Initiative*, 2000. See <http://www.epa.gov/OWOW/oceans/airdep/air3.html>

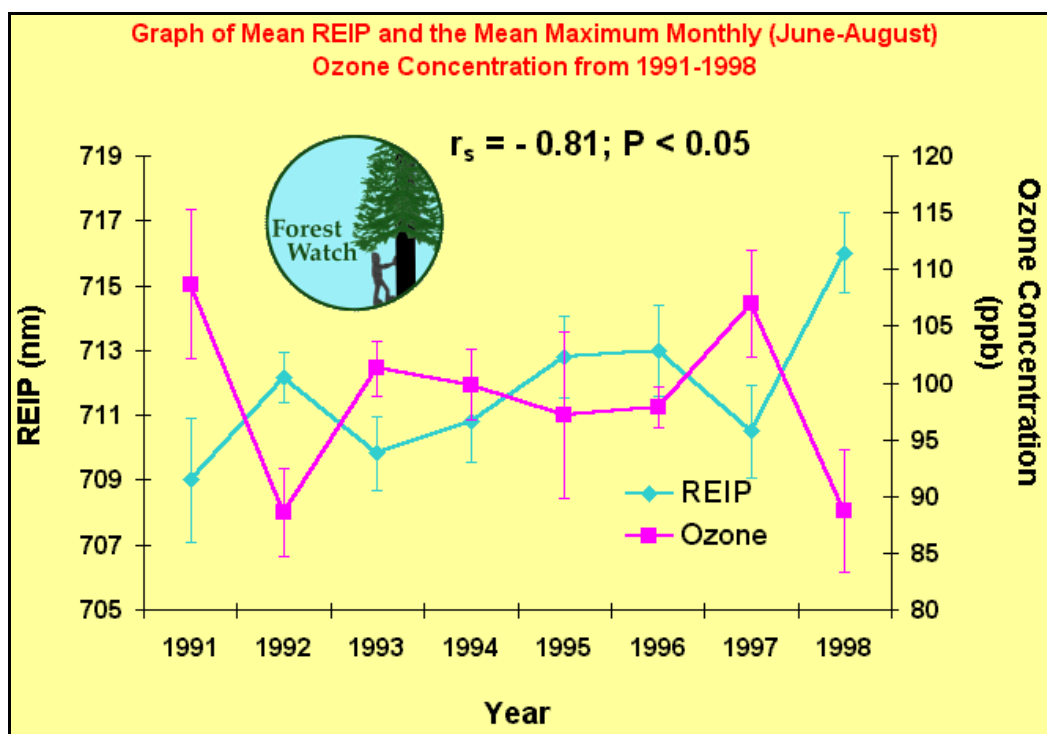
²⁶ Kleinman, Michael T., South Coast Air Quality Management District, *The Health Effects of Air Pollution on Children*, February 1999. See http://www.aqmd.gov/forstudents/Kleinman_article.htm

²⁷ Gauderman, W. James, et al., *Association Between Air Pollution and Lung Function Growth in Southern California Children*, American Journal of Respiratory and Critical Care Medicine, Vol. 162, pp. 1383-1390, 2000. See <http://www.atsjournals.org>

Watch program on white pines at seven sites throughout the State. REIP is a needle health index linked to chlorophyll levels in the pine needles. Higher REIP indicates higher chlorophyll, which in turn indicates a healthier tree or plant.

Figure 4-1 clearly shows that when ozone levels are up, tree health is down, and vice versa. The effects on forest productivity, and the accompanying economic impacts on New Hampshire's natural resource and recreational industries, are obvious. Noticing the coincidence that elevated ozone reduces both the growth of white pines by approximately 15 percent and the lung function of some hikers by approximately 15 percent,²⁸ UNH Forestry Professor and Forest Watch Director Barrett N. Rock wonders if the two may be correlated, perhaps by similar effects at the cellular level.

FIGURE 4-1. Impact of Ozone on White Pine Health as Measured by Red Edge Inflection Point (REIP)



Source: UNH Forest Watch

In response to increasing health concerns, EPA adopted a new, more stringent NAAQS for ground level ozone in July 1997. The old standard – still in effect – set a threshold of 125 parts-per-billion (ppb) over a 1-hour period. The new NAAQS was set at only 85 ppb but is measured over an 8-hour period. The new standard reflects greater concern for lower, more chronic levels of ozone in the atmosphere.

As noted in Chapter 2, the Clean Air Act also enables EPA to set secondary National Ambient Air Quality Standards (NAAQS) in order to adequately protect welfare (e.g.,

²⁸ Korrick, et al., *Effects of Ozone and Other Pollutants on the Pulmonary Function of Adult Hikers*, Environmental Health Perspectives, 106:93, 1998.

economic and quality of life concerns) and the environment. New Hampshire – joined by the U.S. Department of the Interior and the other Northeastern states – has petitioned EPA to set a secondary NAAQS for ground level ozone to address forest productivity and other environmental and welfare impacts. EPA is now taking public comment on this petition.

While peak ozone concentrations have declined over the past ten years, New Hampshire continues to experience unacceptably high levels. Since VOC emissions in New Hampshire are primarily biogenic (i.e., naturally occurring), DES considers NO_x to be the primary controllable cause of elevated ozone concentrations. This conclusion has been substantiated by exhaustive photochemical modeling and air quality analysis conducted by DES, the 37-state Ozone Transport Assessment Group (OTAG), EPA, and others.

4.2. Existing Programs and Commitments

New Hampshire's first phase of NO_x regulations under the federal Clean Air Act Amendments of 1990 required the installation of "Reasonably Available Control Technology" (Env-A 1211 or NO_x RACT) and became effective in 1995. This program established year-round, input-based emission limits (pounds of NO_x emitted per mmBtu heat input of fuel, or lb/mmBtu) for stationary sources. Hourly NO_x emission limits for power plant boilers range from 0.20 lb/mmBtu while burning gas to 1.40 lb/mmBtu while burning coal. DES's NO_x RACT rule was unique, because it included an initial daily tonnage cap (35.4 tons/day), an annual tonnage cap (12,921 tons/year), and a second, more stringent daily tonnage cap (15.4 tons/day) for large, coal-fired boilers under Phase II of the Ozone Transport Commission (OTC) NO_x Memorandum of Understanding (MOU) which became effective in 1999.

DES also issued two RACT orders further regulating existing power plant boilers. RACT Order 97-001 allowed PSNH's Merrimack Station to "bubble" or average the emissions of its two boilers. RACT Order 98-001 established the only "non-ozone season" cap (8,208 tons) implemented to date by any State for the portion of the year (October through April) outside of the ozone season (May through September). This cap applied to all existing power plant boilers in New Hampshire, and it is still the limiting factor for power plant NO_x emissions during non-ozone season operations.

In July 1998, New Hampshire adopted Env-A 3200, the NO_x Budget Trading Program, as part of a regional strategy to reduce NO_x emissions to address the ozone problem. This strategy, outlined in the OTC NO_x MOU, created a three-phased process to reduce NO_x emissions from large fossil fuel-burning boilers in 11 Northeast states during the five-month summer ozone season (i.e., May 1 through September 30). Env-A 3200, which began in May 1999, implements Phase II of the emissions reductions committed to under the OTC NO_x MOU. It established a cap (4,674 tons) on ozone season NO_x emissions for 5 facilities (11 combustion units) in New Hampshire.

The total statewide cap is 5,219 tons of NO_x per ozone season, but the State set aside 445 tons per season for new sources and for energy efficiency projects or renewable energy sources. In addition, 100 tons per season are "retired" (i.e., set aside permanently to benefit the environment). New Hampshire is the only State that retires a portion of its OTC Phase II NO_x Budget. During the first season of the program (summer 1999), New Hampshire

sources emitted only 3,463 tons and achieved a higher aggregate percentage reduction (76.3 percent) from the OTC baseline than any other Northeast state. This achievement was due in part to the incentive provided by the OTC's cap-and-trade program. The opportunity to sell emission reductions that were achieved voluntarily (i.e., beyond required compliance levels) – through the OTC NO_x trading program – made it cost-effective for New Hampshire's facilities to install additional control equipment. This equipment provided earlier and deeper cuts in NO_x than regulations required, allowing New Hampshire to lead the Northeast in reducing NO_x emissions. This market-driven investment in emission control equipment will allow future ozone season NO_x emissions from New Hampshire sources to be even lower.

In April 2000, Env-A 3200 was amended in order to implement Phase III of the OTC NO_x MOU. Phase III will lower New Hampshire's ozone season NO_x emissions cap to 3,739 tons of NO_x per ozone season from 2003 through 2005. As in Phase II, 445 tons per season are set aside for new sources and for energy efficiency projects or renewable energy sources, and 100 tons per season are retired. Thus, Phase III essentially limits NO_x emissions from applicable sources to 3,194 tons of NO_x per ozone season. For Phase III, DES also adopted a phased-in hybrid allowance allocation method that rewards efficient electricity generation.

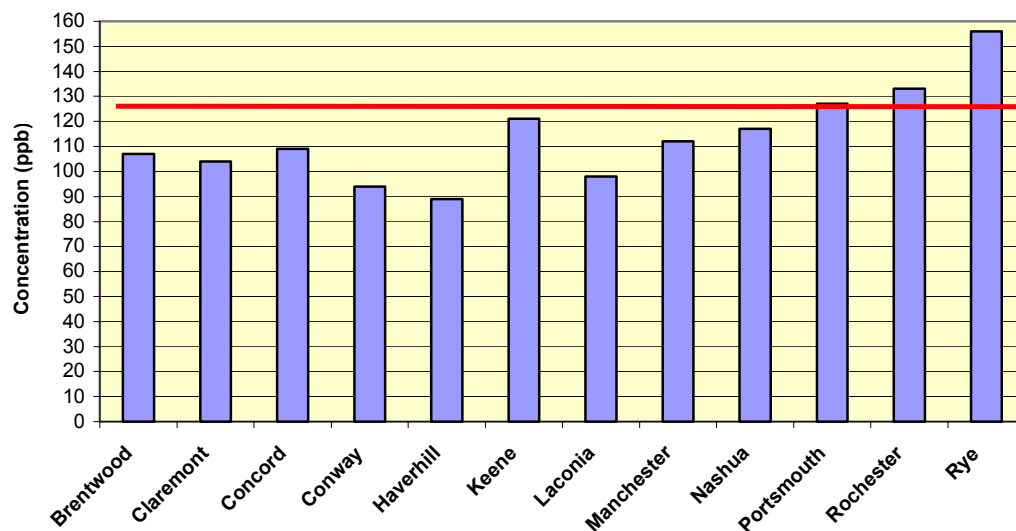
New Hampshire will be the first State to implement its NO_x emission reduction commitments under the New England Governors/Eastern Canadian Premiers Acid Rain Action Plan in its NO_x Budget Trading Program. This will be accomplished by adding a fourth phase of emission reductions to Env-A 3200 that exceeds all emission reduction commitments of the OTC NO_x MOU. Phase IV will cap New Hampshire's ozone season NO_x emissions at 3,000 tons in 2006 and beyond. In Phase IV, DES will also adopt a completely output-based allocation method that rewards efficiency in electric generation. Phase IV will implement the ozone season (summer) portion of New Hampshire's commitment under the New England Governors/Eastern Canadian Premiers Acid Rain Action Plan earlier than specified. The NHCPS will extend these reductions to an annual (year-round) basis.

4.3. Reasons for Further Action

With currently adopted state and federal control strategies, New Hampshire may be able to reach and maintain attainment with the 1-hour NAAQS for ground level ozone (see Figure 4-2), and perhaps even reach attainment with the 8-hour NAAQS (see Figure 4-3). The NHCPS will help ensure this outcome. The additional NO_x controls in the NHCPS will also provide greater public health and environmental benefits, both in terms of ozone and the numerous other air pollution problems to which NO_x contributes (see, for example, Chapters 2 and 3).

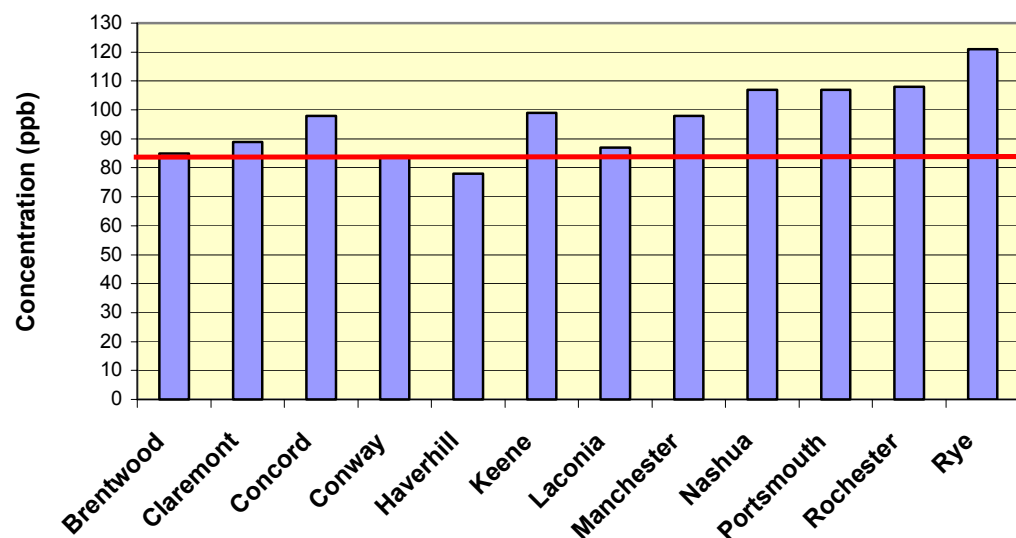
Like PM_{2.5}, ground level ozone is a "zero-threshold pollutant." This means that lowering ozone concentrations provides greater health benefits – all the way down to zero. Since the NAAQS for ground level ozone do not protect all individuals at all times from adverse smog effects, continuing to reduce ambient ozone concentrations will provide further public health protection and environmental benefits.

FIGURE 4-2. New Hampshire 1-Hour Ozone Concentrations
5-Year Maximum Reading, 1996-2000
(Standard = 125 ppb over 1 hour)



Source: DES

FIGURE 4-3. New Hampshire 8-Hour Ozone Concentrations
5-Year Maximum Reading, 1996-2000
(Standard = 85 ppb over 8-Hours)



Source: DES

The New Hampshire Comparative Risk Project ranked ground level ozone in the top 25 percent of environmental risks facing the State,²⁹ and NASA scientist Dr. James Hansen has stated “despite limited success in past efforts to reduce ozone, the human health and ecological impacts of ozone are so great that it represents an opportunity for international cooperation.”³⁰ UNH Professor Barrett Rock’s research indicates that tree health does rebound when ozone concentrations are reduced, and that the forest productivity gains associated with this recovery provide the co-benefit of greater CO₂ sequestration, which can mitigate CO₂’s climate change impacts.

Additionally, the National Academy of Public Administration (NAPA) just completed an exhaustive report, funded by Congress, about how EPA and Congress should transform environmental governance by developing and deploying approaches to environmental protection that can deliver measurable environmental results more effectively and efficiently.³¹ This report to Congress suggests that EPA narrow its current broad environmental focus to three priority items: reducing ozone smog, reducing nutrients in watersheds (see Chapter 6), and reversing the accumulation of greenhouse gases in the earth’s atmosphere (see Chapter 7).

New Hampshire’s 1999 emission inventory indicates that power plants are responsible for about 20 percent of annual NO_x emissions in the State and less than 15 percent of New Hampshire’s NO_x emissions during the ozone season. This fraction is down from 25 percent in 1996 and 45 percent in 1993 due to both aggressive state NO_x regulations and voluntary over-compliance actions undertaken by PSNH in order to take advantage of trading opportunities. Overall annual 1999 NO_x emissions from power plants in New Hampshire are down approximately 68.5 percent from 1990 (see Figure 4-4).

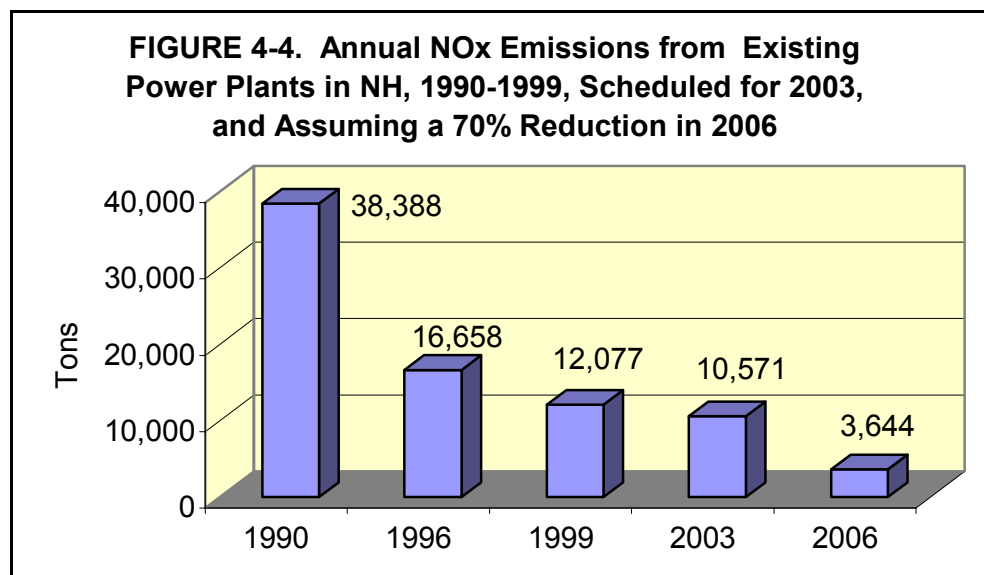
Much remains to be done, however. The 1999 average annual NO_x emission rate for New Hampshire’s coal- and oil-burning power plants – in full compliance with existing federal and state regulations – was 5.0 lbs/MWh, 50 times dirtier than the average annual NO_x emission rate for new, combined cycle natural gas power plants of just 0.1 lbs/MWh. Under federal New Source Performance Standards (NSPS), new coal plants are required to meet a NO_x emission rate limit of 0.15 lbs/mmBtu, which is approximately equivalent to 1.5 lbs/MWh.

In as much as further NO_x reductions are necessary to improve public health, agriculture and forest productivity, and the general environment, the NHCPS recommends a 70 percent further reduction in annual NO_x emissions beyond current levels, implemented using market-based measures and an emissions cap based on 1.5 lbs/MWh, applicable to New Hampshire’s existing coal- and oil-burning power plants as called for in New Hampshire RSA 374-F:3,VIII. The NHCPS recommends that this reduction requirement for NO_x take effect in 2006.

²⁹ New Hampshire Comparative Risk Project, *Report of Ranked Environmental Risks in New Hampshire, 1 May 1997*. See http://www.scorecard.org/comp-risk/report.tcl?fips_state_code=33

³⁰ Hansen, James et al., *Global Warming in the Twenty-first Century: An Alternative Scenario*, Proceedings of the National Academy of Sciences, Vol. 97, Issue 18, 9875-9880, August 29, 2000. See <http://www.pnas.org/cgi/doi/10.1073/pnas.170278997>.

³¹ National Academy of Public Administration, *Transforming Environmental Protection for the 21st Century*, November 2000. See <http://www.napawash.org/napa/environdotgov.pdf>



Source: US EPA and DES

This NO_x reduction will provide multiple additional benefits beyond reducing ground level ozone concentrations. These benefits include, for example, additional human health gains through less acid deposition (see Chapter 2) and less particulate matter formation (see Chapter 3), greater agricultural and forestry productivity as well as ecosystem integrity, less eutrophication and nitrification (see Chapter 6), less climate change because one form of NO_x (nitrous oxide or N₂O) is also a greenhouse gas (see Chapter 7), better visibility (see Chapter 8), and the attendant economic benefits to recreational and natural resource industries (see Chapter 12). These reductions will also help level the competitive playing field between “grandfathered” power plants and new facilities, as called for in New Hampshire RSA 374-F:3,VIII.

In addition, many measures to reduce NO_x emissions have simultaneous “co-benefit” effects, reducing other pollutants. Selective catalytic reduction (SCR) technology apparently helps reduce mercury emissions, for example, while derating and fuel switching dramatically reduce emissions of SO₂, CO₂, mercury, and other toxic compounds as well as NO_x. Energy efficiency measures – which avoid having to generate electricity in the first place – are most effective means of reducing air pollution, since they avoid all emissions of all pollutants, and simultaneously save users the money they would have spent to buy the electricity.

Since other source categories – notably transportation sources – are also substantial NO_x emitters, additional pollution reductions are also necessary from these sources. Several of DES’s efforts in pursuit of NO_x reductions from other emission sources are described in Chapter 10.

5. MERCURY AND DIOXIN

5.1. Characterization of the Problem

Mercury and dioxin are persistent, bioaccumulative toxics (PBTs). PBTs are chemicals that are generally emitted into the environment at very low or even non-detectable levels. The following characteristics, however, make them significant environmental threats:

- They break down very slowly allowing their concentrations to build up in the environment over time;
- They accumulate in the bodies of people and animals when ingested, and increase in concentration as they move up the food chain;
- They are linked to toxic effects on the nervous, immune and reproductive systems, developmental problems, cancer and endocrine disruption in fish, wildlife and humans;
- They can be transported long distances from where they are emitted by wind, precipitation and water currents.

DES has identified PBTs as significant pollutants of concern in New Hampshire and has been working to address their impacts. In October 1998, for example, DES published the *New Hampshire Mercury Reduction Strategy*. Since then, DES has worked, through legislative, regulatory, and public policy channels at the state, regional, national, and international level to implement programs and measures to reduce emissions of this neurotoxic pollutant. A similar effort to address dioxin emissions is now under development at DES, and a *New Hampshire Dioxin Reduction Strategy* will be published soon. The following sections provide a summary of mercury and dioxin issues in New Hampshire.

5.1.1. Mercury

Mercury has long been known to be a toxic, persistent, bioaccumulative pollutant with a wide range of human health and ecosystem impacts. The primary health effects from mercury are on the development of the brain and nervous system of children who eat contaminated fish, and in fetuses whose mothers eat contaminated fish. It is likely that subtle nervous system and developmental effects (such as attention deficit disorder) occur in children chronically exposed to relatively low concentrations of mercury. Exposure to high concentrations of mercury over a long period of time can also result in brain damage in adults. It is also thought that serious nervous system and reproductive disorders are occurring in some populations of fish-eating birds and mammals.³²

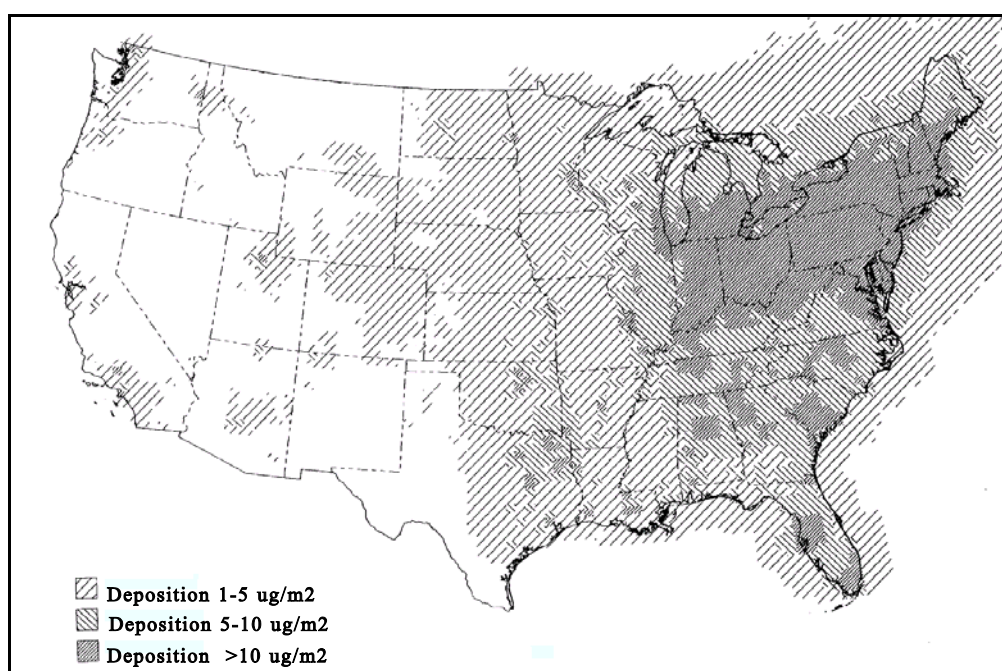
Mercury is released into the environment through emissions to the air, direct discharges to surface water and soil, accidental spills, and some natural processes. Although all releases of mercury are of concern, air emissions are most significant in terms of transport and deposition of mercury. Approximately 47 percent of mercury deposition in the Northeast (New England, New York, and New Jersey) is attributable to sources within the region and

³² U.S. Environmental Protection Agency, Office of Water, *Air Pollution and Water Quality, Atmospheric Deposition Initiative*, 2000. See <http://www.epa.gov/OWOW/oceans/airdep/air3.html>

53 percent comes from upwind and global sources.³³ Figure 5-1 illustrates that mercury deposition levels in the Northeast are among the highest in the nation.

Once emitted into the air, mercury can be transported long distances and undergo several chemical transformations cycling through land, water, and air. Methylmercury, a particularly toxic form of mercury, bioaccumulates in fish and is then ingested by fish-eating wildlife and humans. Adult loons in New England have been found to have the highest average blood mercury levels in the United States.³⁴ In humans, exposure to methylmercury can impair the nervous system and kidney function, among other serious health effects. Exposure in utero can cause neo-natal brain damage and developmental effects in children.

FIGURE 5-1. Anthropogenic Mercury Deposition Rates in the United States



Source: US EPA, Mercury Study Report to Congress, December 1997.

Evidence of elevated mercury in fish taken from waterbodies throughout the US and Canada has prompted widespread concern about health and environmental impacts. In response, many jurisdictions, including all of the Northeastern states and three eastern Canadian provinces, have issued public health advisory warnings regarding fish consumption. The New Hampshire Department of Health and Human Services, Bureau of Health Risk Assessment, recommends that young children and women of childbearing age limit their consumption of freshwater fish to no more than one meal per month. Other individuals are encouraged to limit their intake to no more than four fish meals per month.

³³ New Hampshire Department of Environmental Services, *New Hampshire Mercury Reduction Strategy*, October 1998. See <http://www.des.state.nh.us/nhcpp/merc20.htm>

³⁴ Evers, David, et al., *Assessing the Impacts of Methylmercury on Piscivorous Wildlife as Indicated by the Common Loon, 1998-1999*, BioDiversity Research Institute, March 31, 2000.

5.1.2. Dioxin

The term “dioxin” refers to a group of chemical compounds that share certain similar chemical characteristics and common mechanisms of toxicity. Many individual dioxin-like compounds exist, all members of a group of chemicals known as polychlorinated dibenzo-p-dioxins (PCDDs) and polychlorinated dibenzo-p-furans (PCDFs). The most toxic and well-studied individual dioxin compound is known as 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD).

Dioxins are produced both naturally (from sources such as forest and wild fires) and as by-products of a number of human activities including combustion processes. Although dioxins are released into the environment in very minute quantities, they build up in soils, sediments and plants, bioaccumulate in animal and fish tissue, and are then passed up the food chain to people. Dioxins are very potent toxicants that can produce a number of adverse effects in humans including reproductive and developmental disorders, suppression of the immune system, and cancer.

Once emitted into the air, dioxin can travel great distances due to prevailing winds and upper air currents. Much of it is then washed out of the air by precipitation and deposited on land and into water bodies. This transported airborne dioxin, combined with sources of dioxin within New Hampshire, results in increased levels in local vegetation, crops, farm animals, fish and wildlife.

Dioxin is a byproduct of combustion and of certain chemical processes. It is created through a reaction of chlorine and organic molecules. The burning of oil and coal in New Hampshire’s power plant boilers causes small amounts of dioxin emissions because these fuels contain chlorine and organic precursors that react during combustion to form dioxin. Together, New Hampshire’s three fossil fuel-fired power plants emit about 3.5 percent of the state’s annual dioxin emissions.

5.2. Existing Programs and Commitments

5.2.1 Mercury

New Hampshire does not currently have regulations in place specifically limiting mercury emissions from fossil fuel-burning power plants. Although current control technologies to reduce SO₂, NO_x, and particulate matter may also reduce mercury emissions, control technologies specifically designed to reduce mercury from coal-burning power plants are not yet commercially available. Several promising technologies, however, appear to be nearing that point.

In July 2000, the New England Governors’ Conference (including the State of New Hampshire) and the Eastern Canadian Premiers (NEG/ECP) charged their joint Mercury Task Force to begin development of strategies to reduce mercury emissions from boilers, in order to meet the reduction targets cited in the report of its Joint Boiler Work Group. This report, *Technology Options and Recommendations for Reducing Mercury and Acid Rain Precursor Emissions from Boilers*, recommends reducing total annual regional mercury

emissions (on a mass basis) from coal-burning electric power plants by 20-50 percent from 1995 levels by January 2005, and by 60-90 percent by January 2010.

Since the majority of mercury deposited in the Northeast originates outside the region, it is critical that New Hampshire and other Northeast states set an example of environmental leadership for other jurisdictions to follow. As a result, as part of the *New Hampshire Mercury Reduction Strategy*, a multi-stakeholder workgroup has been assessing the technical and economic feasibility of achieving a 75 percent reduction in mercury emissions from coal-burning power plants by 2005.

DES believes that mercury reductions on this scale are achievable in this timeframe for several reasons. First, through a 1998 Information Collection Request (ICR) to coal-fired power plants, EPA has been analyzing data on the amount and types of mercury being emitted from the nation's coal-burning power plants. Based on the results of this analysis, EPA made a regulatory determination on December 14, 2000 to regulate mercury emissions from coal- and oil-burning power plants under Section 112 of the federal Clean Air Act.³⁵ EPA plans to propose specific regulations by December 15, 2003 and to finalize them one year later. After finalizing such regulations, EPA normally provides a significant period of time (e.g., three years typically) for sources to come into compliance with their requirements.

Preliminary results of EPA's ICR appear to indicate that existing controls for NO_x (e.g., SCR), SO₂ (e.g., acid gas scrubbers), and/or particulate matter (e.g., electro-static precipitators or ESPs) may also reduce mercury emissions substantially. This assessment is shared by the Institute for Clean Air Companies (ICAC):

*Data from EPA's recent collection of information on mercury emissions from coal-fired power generators, as well as from ICAC's own Mercury Task Force, show that air pollution control technology already in-use and well-demonstrated can be enhanced to cut mercury emissions significantly. The best way to achieve cost-effective mercury control is to look to a multi-pollutant approach, both in terms of policy and technology, that would see to control mercury emissions along with criteria pollutants such as NO_x, SO₂, and particulate matter.*³⁶ [emphasis added]

Second, new, multi-pollutant control technologies that address mercury emissions are rapidly developing.³⁷ In addition, a September 2000 report by the Northeast States for Coordinated Air Use Management (NESCAUM), *Environmental Regulation and Technology Innovation: Controlling Mercury Emissions from Coal-Fired Boilers*³⁸ indicates that concerted technology development typically does not occur until regulatory drivers – such as those proposed by the NHCPS – are in place. This is to be expected, because without such

³⁵ U.S. Environmental Protection Agency, Fact Sheet, *EPA to Regulate Mercury and Other Air Toxics Emissions from Coal- and Oil-Fired Power Plants*, December 14, 2000. See <http://www.epa.gov/ttn/oarpg>

³⁶ Institute of Clean Air Companies, *Conventional controls, Multi-pollutant Approach Can Aid EPA in Mercury Initiative*, Press Release, December 14, 2000. See <http://www.icac.com>

³⁷ For example, Powerspan Corporation's Electro-Catalytic Oxidation (ECO). *ECO Technology Demonstrates Unmatched Reductions in Mercury and Fine Particulate Matter*, August 23, 2000. See http://www.powerspancorp.com/news/release_05.html

³⁸ Northeast States for Coordinated Air Use Management, *Environmental Regulation and Technology Innovation: Controlling Mercury Emissions from Coal-Fired Boilers*. September 2000. See <http://www.nescaum.org/pdf/hg-release.pdf>

regulation, there is no market for technology developers' products. Finally, the NHCPS recommends a statewide cap on mercury emissions. Operational changes (such as displacement by cleaner generating facilities) can thus contribute to achieving compliance.

5.2.2. Dioxin

DES is in the process of finalizing a *New Hampshire Dioxin Reduction Strategy*. This strategy identifies power plant boilers as contributing approximately 3.5 percent of the state's total annual dioxin emissions. This percentage may increase as other sources of dioxin reduce their emissions over the next few years. No current state or federal regulations directly control dioxin emissions from fossil fuel-burning electric power plants. However, significant dioxin reductions have been or soon will be achieved through new regulations which apply to medical waste incinerators and municipal solid waste combustors. The elimination of backyard burning of household trash also can help reduce dioxin emissions substantially.

In recent years, air pollution controls have been added at power plants that have greatly reduced emissions of particulate matter. These particulate controls may also significantly reduce dioxin emissions. In 1998, power plants were required to report annual emissions of several hazardous air pollutants under EPA's *Toxics Release Inventory* (TRI). Beginning in 2001, these facilities will also be required to report annual dioxin emissions through the TRI.

5.3. Reasons for Further Action

5.3.1. Mercury

A recent report by the National Wildlife Federation found that mercury concentration in the rainwater falling on New England is substantially higher than that EPA considers safe for people, aquatic life, and wildlife in surface waters. In fact, mercury concentrations in rain along the coast of New Hampshire are up to four times the EPA standard for aquatic life and wildlife.³⁹ Since mercury cycles through the environment very slowly, it is important to initiate programs now to reap future public health and wildlife benefits. Over time, regional reductions in anthropogenic mercury emissions will decrease the amount of mercury available for methylation and subsequent uptake in fish populations. This will result in lower methylmercury levels in fish tissue, and lower exposure rates to the humans and animals that consume fish.

Mercury is a trace element in coal and oil, so it is emitted into the air during combustion of these fuels. New Hampshire's 1997 mercury inventory indicated that coal- and oil-burning power plants were responsible for approximately 24 percent of mercury emissions in the state.⁴⁰ Mercury may also be emitted in trace amounts from motor vehicles, although EPA has not yet developed emission factors for mercury emitted from this source category. The State's mercury reduction efforts to date have primarily targeted sources other than power

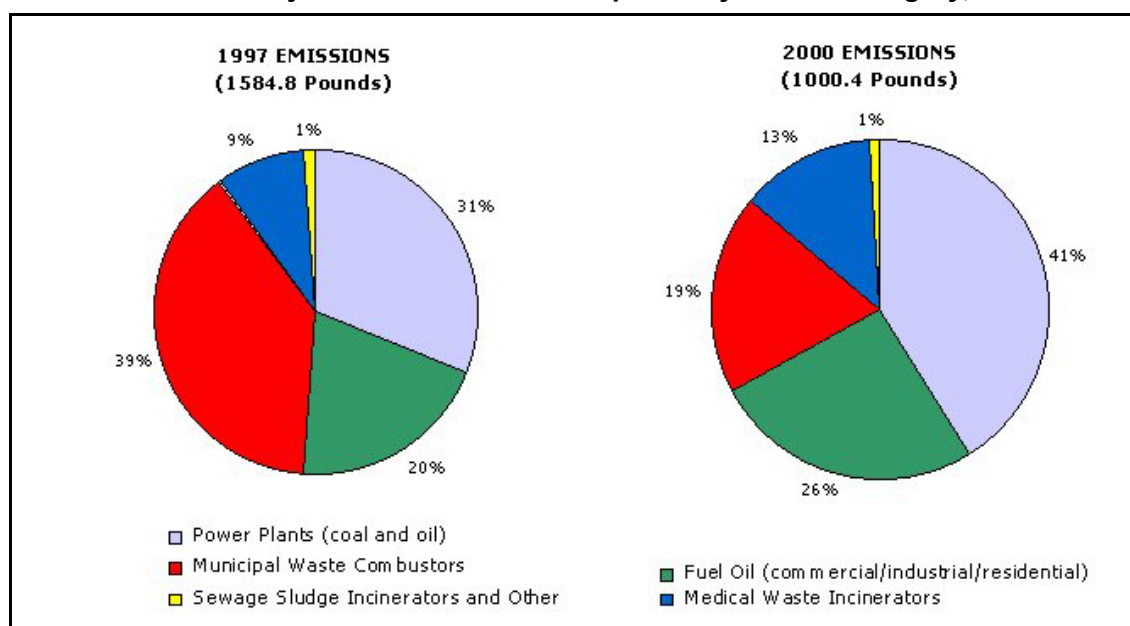
³⁹ National Wildlife Federation, *Clean the Rain, Clean the Lakes II*, September 2000, p 1. See <http://www.nwf.org/cleantherain/ctriipress.html>

⁴⁰ New Hampshire Department of Environmental Services, *New Hampshire Mercury Reduction Strategy*, October 1998. See <http://www.des.state.nh.us/nhppp/merc20.htm>

plants due to the commercial availability of mercury reduction technologies for these sources. These efforts have achieved a 37 percent decrease in statewide mercury emissions from 1997 through 2000 (see Figure 5-2). As a result of this reduction, however, coal- and oil-burning power plants now comprise approximately 40 percent of the State's mercury emissions.

Mercury reductions are necessary to better protect public health – particularly children's health – and wildlife, and to fulfill the commitments that New Hampshire has made relative to the NEGC/ECP Mercury Action Plan and the State's own *Mercury Reduction Strategy*. In addition, mercury reduction requirements will help drive the development of new mercury control technologies, and give New Hampshire sources a potential advantage regarding expected future federal regulations on mercury emissions from coal-burning electric power plants.

FIGURE 5-2. Mercury Emissions in New Hampshire by Source Category, 1997 & 2000



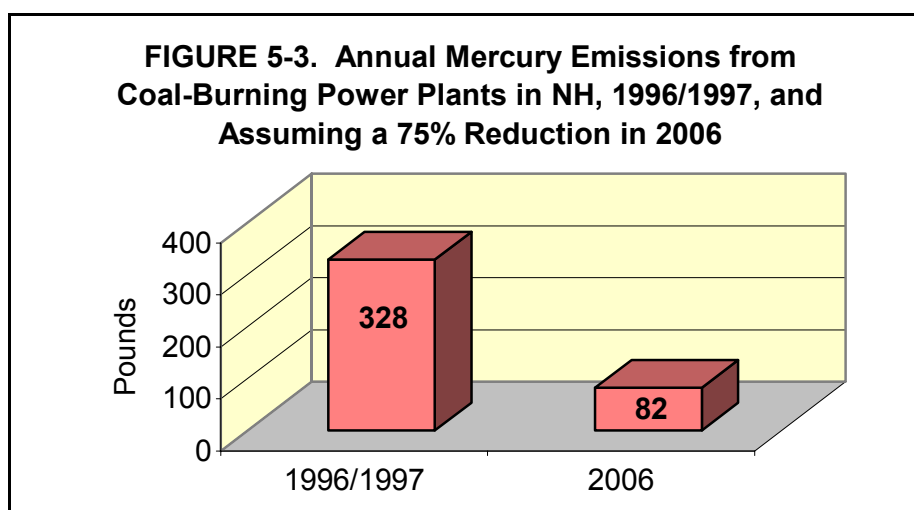
Source: DES

In addition, measures to reduce mercury emissions are expected to result in simultaneous “co-benefit” reductions in other pollutants, such as SO₂ (see Chapter 2), PM_{2.5} (see Chapter 3), NO_x (see Chapter 4), and other toxic contaminants (see Chapter 9), and carbon dioxide (see Chapter 7). Energy efficiency measures – which avoid having to generate electricity in the first place – are among the most effective means of reducing air pollution, since they avoid all emissions of all pollutants, and simultaneously save users the money they would have spent to buy the electricity.

These mercury emissions reductions, depending upon the choice of control technology, could provide multiple additional benefits as well, including human health gains through less acid deposition (see Chapter 2), less particulate matter formation (see Chapter 3), less ground level ozone (see Chapter 4), enhanced ecosystem integrity, less eutrophication and nitrification of waterbodies (see Chapter 6), better visibility and enhanced scenic quality (see

Chapter 8), and the attendant economic benefits to recreational and natural resource industries (see Chapter 12). They will also help level the competitive playing field between “grandfathered” power plants and new facilities, as called for in New Hampshire RSA 374-F:3,VIII.

The NHCPS seeks to provide New Hampshire citizens with the mercury reduction benefits enumerated above by recommending a cap on mercury emissions 75 percent lower than 1996/1997 baseline emissions from New Hampshire’s coal-burning power plants. The NHCPS recommends that this reduction requirement for mercury take effect in 2006. Figure 5-3 illustrates this recommended reduction in mercury emissions from coal-burning power plants. Several of DES’s efforts in pursuit of similar mercury reductions from other emission sources are described in the *New Hampshire Mercury Reduction Strategy*.



Source: DES

5.3.2. Dioxin

The *New Hampshire Dioxin Reduction Strategy* places more emphasis on other, more significant sources of dioxin emissions in New Hampshire, including medical waste incinerators, large wood-burning plants, municipal solid waste combustors, and backyard burning of household trash. The *Strategy* does, however, include recommendations for dioxin emission reductions from power plant boilers through cleaner generation (e.g., natural gas); greater implementation of energy efficiency and conservation programs; expeditious development of alternative energy technologies (e.g., photovoltaics and fuel cells) through both the permitting process and by allocating SO₂ and NO_x allowances on an output basis.

Recognizing that the NHCPS also includes or encourages many of these approaches, DES believes that the NHCPS will result in a small reduction in dioxin emissions. The fact that the New Hampshire Public Utilities Commission recently approved greater funding for energy efficiency activities in the State⁴¹ should also encourage emission reductions in dioxin and other pollutants of concern.

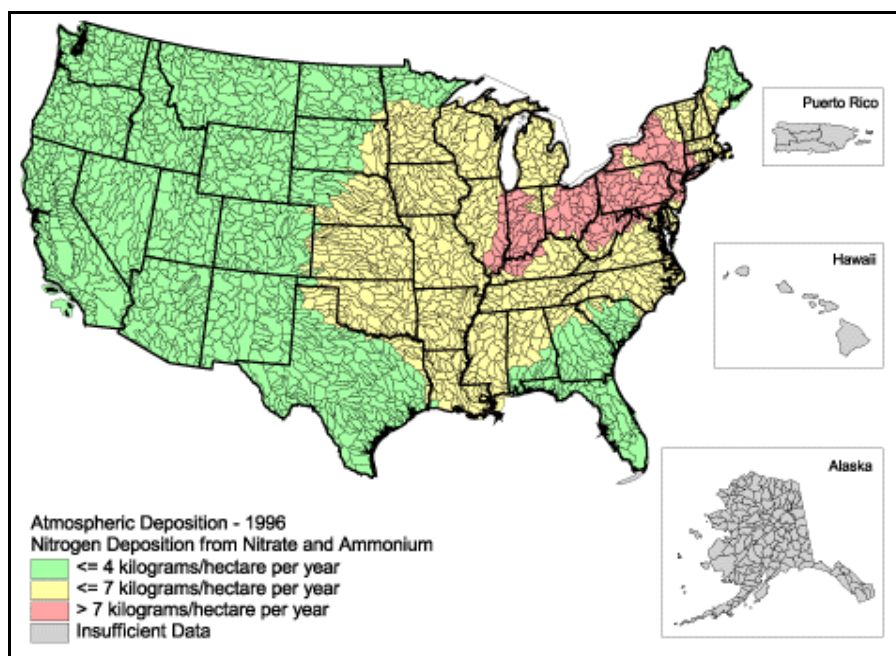
⁴¹ New Hampshire Public Utilities Commission, Order Nos. 23,574, *Energy Efficiency Programs*, and 23,575, *Allocation of System Benefits Charge*, November 1, 2000. See <http://www.puc.state.nh.us/>

6. EUTROPHICATION AND NITRIFICATION OF SURFACE WATERS

6.1. Characterization of the Problem

In addition to the water quality problems created by acid deposition (see Chapter 2 and Figure 2-1) and mercury (See Chapter 5 and Figure 5-1), nitrogen also accumulates in watersheds due to atmospheric deposition. Nitrogen is an essential nutrient for life – it is a fertilizer that we add to lawns, gardens, and farms. Normally in short supply, nitrogen plays an important role in controlling the productivity, dynamics, biodiversity, and nutrient cycling of estuarine and marine ecosystems. During the past century, however, human activities have doubled the amount of nitrogen available annually to living organisms. In many coastal waters, human sources of nitrogen now rival or exceed natural inputs of nitrogen. **From 10-45 percent of the anthropogenic nitrogen reaching estuarine and coastal ecosystems is transported and deposited via the atmosphere.**⁴² The highest atmospheric contributions are observed in the Northeast and mid-Atlantic watersheds of the United States.⁴³ Echoing a familiar deposition pattern for all of the pollutants of concern, Figure 6-1 shows EPA's 1996 atmospheric deposition estimates for total nitrogen over the United States.⁴⁴

FIGURE 6-1. Atmospheric Deposition Estimates for Total Nitrogen, 1996



Source: US EPA

⁴² Ecological Society of America, *Atmospheric Nitrogen Deposition to Coastal Watersheds*, Sustainable Biosphere Initiative Project, Workshop Report, June 2-4, 1997. See <http://www.sdsc.edu/~ESA/sbindep1.htm>

⁴³ Alexander, Richard B., et al., *Atmospheric Nitrogen Flux From the Watersheds of Major Estuaries of the United States*, in *Nitrogen Loading in Coastal Water Bodies: An Atmospheric Perspective*, American Geophysical Union Monograph 57, 2000. See http://water.usgs.gov/nawqa/sparrow/coast/agu_sparrow.html

⁴⁴ U.S. Environmental Protection Agency, *Index of Watershed Indicators*, 1999. See http://www.epa.gov/iwi/1999april/iii17_usmap.html

In excessive amounts, nitrogen has proven to be a significant problem in the nitrogen-sensitive waters of bays and estuaries. Excess nitrogen contributes to a decrease in overall water quality, and has been linked to increases in the occurrence of harmful algal blooms like “red tides” and “brown tides” as well as to outbreaks of *Pfiesteria*. Excess nitrogen also alters the food web and the ecological make-up of coastal and other aquatic ecosystems.⁴⁵ Because most North American terrestrial ecosystems are nitrogen-limited, nitrogen deposition often has an initial fertilizing effect, accelerating plant and algae growth. Sustained nitrogen deposition (such as that experienced over the last 100-150 years in the Northeast) can cause adverse changes in terrestrial ecosystems, including shifts in plant species composition, decreases in species diversity, nitrate leaching to surface and ground waters, and ultimately, decreased plant growth.

NO_x emissions also contribute directly to accelerated eutrophication of coastal waters and estuaries. Atmospheric nitrogen deposition has been documented to contribute up to 44 percent of the total nitrogen loading to coastal waterbodies in the United States.⁴⁶ This nitrogen contributes to accelerated algae and aquatic plant growth, causing adverse ecological effects and economic impacts that range from nuisance algal blooms to oxygen depletion and fish kills.

6.1.1. Eutrophication

Eutrophication is the over-enrichment of nutrients in a waterbody. An increase in nitrogen concentrations in estuaries and coastal waters often leads to low oxygen (hypoxia) or no oxygen (anoxia) conditions in bottom waters due to the decomposition of algal blooms. Hypoxia in some areas, such as Long Island Sound, has become a recurring event with significant economic consequences. Eutrophication also contributes to the loss of diversity in the sea floor community (including seaweeds, seagrasses, and corals), and among planktonic organisms. Planktonic algae are the basis of marine food chains, and a change in the dominant species can have a domino effect throughout the food chain. In cases where nuisance algae come to dominate the algal community, toxic or nuisance algal blooms result. Over-enrichment of nutrients appears to be at least partly to blame for the more frequent occurrence of nuisance algal blooms and the resulting extensive die-offs of fish and shellfish in estuaries and coastal waters.⁴⁷

6.1.2. Nitrification

There has been a dramatic rise in nitrogen concentrations in drinking water supplies, much of which comes from air sources as well as fertilizer and animal wastes. In the major rivers of the Northeastern states, nitrate concentrations have risen three- to ten-fold since the early 1900s.

⁴⁵ U.S. Environmental Protection Agency, Office of Water, *Air Pollution and Water Quality, Atmospheric Deposition Initiative*, 2000. See <http://www.epa.gov/OWOW/oceans/airdep/air3.html>

⁴⁶ National Research Council, Committee on the Causes and Management of Eutrophication, *Clean Coastal Waters: Understanding and Reducing the Effects of Nutrient Pollution*, Summer 2000. Project ID: OSBX-U-97-02-A.

⁴⁷ U.S. Environmental Protection Agency, Office of Water, *Air Pollution and Water Quality, Atmospheric Deposition Initiative*, 2000. See <http://www.epa.gov/OWOW/oceans/airdep/air3.html>

Nitrates are a human health hazard if they are present in high concentrations (greater than 10 milligrams per liter of water). Acute nitrate contamination is linked to a condition that occurs primarily in infants called methemoglobinemia or “Blue Baby Syndrome.” The condition is rare, but it occurs when oxygen in hemoglobin (the compound in the blood that carries oxygen from the lungs to the rest of the body) is replaced by nitrite and causes mild to severe oxygen deprivation, which can result in brain damage and death. Researchers are also investigating a possible link between high levels of nitrate in drinking water and non-Hodgkins lymphoma, a cancer of the lymphatic system. These health effects are expected to become more widespread if the geographic distribution and extent of nitrate contamination continues to rise.⁴⁸ For these reasons, nitrates in surface waters and groundwater were included by the New Hampshire Comparative Risk Project on its list of 53 environmental risks facing the State.⁴⁹

6.2. Existing Programs and Commitments

New Hampshire currently has no regulatory program in place to specifically address eutrophication⁵⁰ and nitrification of surface waters due to emissions from fossil fuel-burning power plants. Since NO_x emissions are the primary source of nitrogen emitted from these facilities, New Hampshire’s aggressive NO_x emission control programs should help address this environmental problem. In addition, the DES Water Division’s *Watershed Assistance Program* (formerly the *Nonpoint Source Program*)⁵¹ has been working with local organizations, other programs within DES, and EPA New England (EPA Region I)⁵² to improve water quality in New Hampshire at the watershed level. DES is also working with citizens in local watersheds to identify water resource goals and to develop and implement watershed management plans.

6.3. Reasons for Further Action

A recent study by a National Academy of Sciences’ National Research Council panel conclude that an overabundance of nutrients – especially nitrogen – is causing serious environmental damage on all of the nation’s coasts. This study calls for reductions in nitrogen loading from the atmosphere due to the burning of fossil fuels, and from upstream watersheds due to pollution from agricultural runoff (e.g., from fertilizer use) and from wastewater treatment plants.⁵³

Moreover, the National Academy of Public Administration (NAPA) just completed an exhaustive report, funded by Congress, about how EPA and Congress should transform environmental governance by developing and deploying approaches to environmental

⁴⁸ Ibid.

⁴⁹ New Hampshire Comparative Risk Project, *Report of Ranked Environmental Risks in New Hampshire*, 1 May 1997. See http://www.scorecard.org/comp-risk/report.tcl?fips_state_code=33

⁵⁰ New Hampshire Department of Environmental Services, *Environmental Fact Sheet: Lake Eutrophication*, 1995. See <http://www.des.state.nh.us/factsheets/bb/bb-3.htm>

⁵¹ New Hampshire Department of Environmental Services, *Watershed Assistance Program* (formerly the *Nonpoint Source Program*), 2000. See <http://www.des.state.nh.us/wmb/was/>

⁵² U.S. Environmental Protection Agency, Region I (New England), *Rivers/Watersheds*, 2000. See <http://www.epa.gov/region01/topics/water/watersheds.html>

⁵³ Ibid.

protection that can deliver measurable environmental results more effectively and efficiently.⁵⁴ This report to Congress suggests that the EPA narrow its current broad environmental focus to three priority items: reducing nutrients in watersheds, reducing ozone smog (see Chapter 4), and reversing the accumulation of greenhouse gases (see Chapter 7).

Since power plants that burn coal or oil are a major source of the NO_x emissions that result in nitrogen deposition, New Hampshire may not be able to achieve its water quality improvement goals without significant emissions reductions from power plants. Recognizing that further NO_x reductions are necessary to help reduce eutrophication and nitrification of the State's waters, the NHCPS recommends a 70 percent further reduction in annual NO_x emissions beyond current levels, implemented using market-based measures and an emissions cap based on 1.5 lbs/MWh, applicable to New Hampshire's existing coal- and oil-burning power plants as called for in New Hampshire RSA 374-F:3, VIII. The NHCPS recommends that this reduction requirement for NO_x take effect in 2006.

These NO_x reductions will provide multiple additional benefits beyond reducing eutrophication and nitrification. These include, for example, additional human health gains through less acid deposition (see Chapter 2) and less particulate matter formation (see Chapter 3), less ground level ozone formation (see Chapter 4), greater agricultural and forestry productivity as well as ecosystem integrity, less climate change because one form of NO_x (nitrous oxide or N₂O) is also a greenhouse gas, better visibility and enhanced scenic quality (see Chapter 8), and the attendant economic benefits to recreational and natural resource industries (see Chapter 12). These reductions will also help level the competitive playing field between "grandfathered" power plants and new facilities, as called for in New Hampshire RSA 374-F:3, VIII.

In addition, many measures to reduce NO_x emissions have simultaneous "co-benefit" effects, reducing other pollutants. Selective catalytic reduction (SCR) technology apparently helps reduce mercury emissions, for example, while derating and fuel switching dramatically reduce emissions of SO₂, CO₂, mercury, and other toxic compounds as well as NO_x. Energy efficiency measures – which avoid having to generate electricity in the first place – are most effective means of reducing air pollution, since they avoid all emissions of all pollutants, and simultaneously save users the money they would have spent to buy the electricity.

Since other source categories – notably transportation sources – are also substantial NO_x emitters, additional pollution reductions are also necessary from these sources. Several of DES's efforts in pursuit of NO_x reductions from other emission sources are described in Chapter 10.

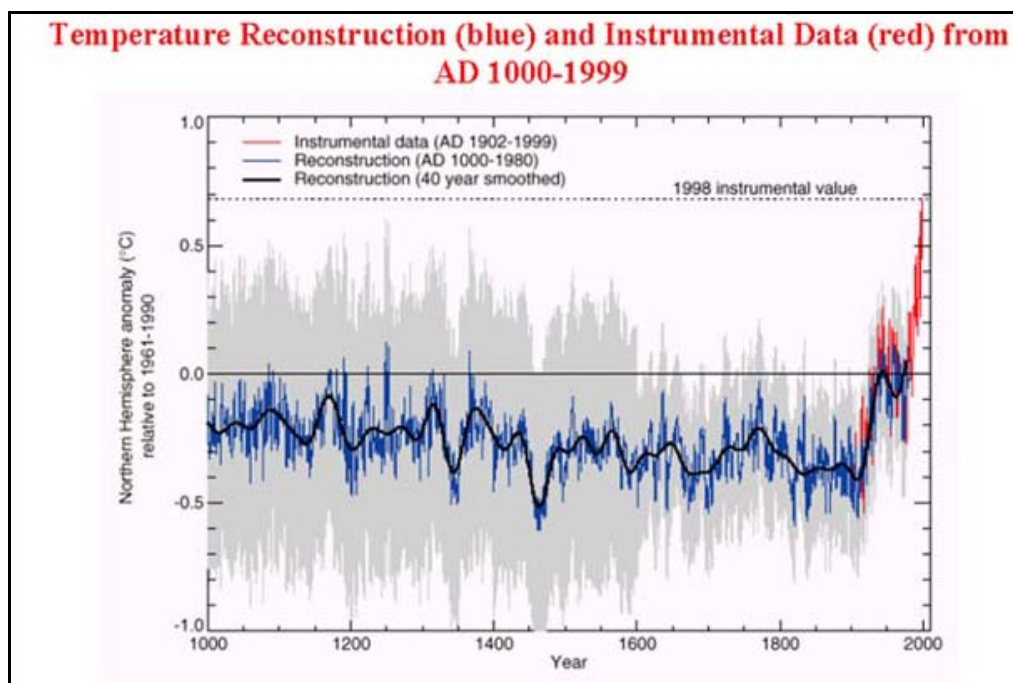
⁵⁴ National Academy of Public Administration, *Transforming Environmental Protection for the 21st Century*, November 2000. See <http://www.napawash.org/napa/environdotgov.pdf>

7. CLIMATE CHANGE

7.1. Characterization of the Problem

Greenhouse gases trap heat within the earth's atmosphere, warming the planet sufficiently to sustain life as we know it. During the last few decades, however, international concern has mounted that increased atmospheric concentrations of anthropogenic greenhouse gases are changing the earth's climate in ways that will be detrimental to the long-term health and well-being of mankind. Abundant data now demonstrate conclusively that the climate has warmed, and today there is broad scientific consensus on this fact. Using data reconstructed from ice cores, Figure 7-1 illustrates the dramatic temperature change that has been underway since the Industrial Revolution, when the combustion of fossil fuels (mainly coal) for steam power began in earnest.⁵⁵

FIGURE 7-1. Northern Hemisphere Temperature Change Over the Last Thousand Years



Source: IPCC

Scientific consensus is also strengthening that human activities are largely responsible for this change. As the forthcoming “Third Assessment Report” by the Intergovernmental Panel on Climate Change (IPCC) will demonstrate, man’s actions have contributed substantially to the warming observed over the last 50 years.⁵⁶ As Robert T. Watson, Chair of the IPCC, indicated at the opening of international climate talks in The Hague on November 13, 2000:

⁵⁵ Watson, Robert T., *Presentation to the Sixth Conference of the Parties to the United Nations Framework Convention on Climate Change*, November 13, 2000. See <http://www.ipcc.ch/press/sp-cop6.htm>

⁵⁶ Intergovernmental Panel on Climate Change, *Third Assessment Report* (Draft), 2000. See <http://www.ipcc.ch/pub/reports.htm>

The question is not whether climate will change in response to human activities, but rather how much (magnitude), how fast (the rate of change) and where (regional patterns). It is also clear that climate change will, in many parts of the world, adversely affect socio-economic sectors, including water resources, agriculture, forestry, fisheries and human settlements, ecological systems (particularly forests and coral reefs), and human health (particularly diseases spread by insects). ... The good news is, however, that the majority of experts believe that significant reductions in net greenhouse gas emissions are technically feasible due to an extensive array of technologies and policy measures in the energy supply, energy demand and agricultural and forestry sectors. ... These are the fundamental conclusions, taken from already approved/accepted IPCC assessments, of a careful and objective analysis of all relevant scientific, technical and economic information by thousands of experts from the appropriate fields of science from academia, governments, industry and environmental organizations from around the world.⁵⁷

Watson also indicated that based on the latest climate model refinements, the IPCC now project increases in global mean surface temperatures of about 1.5°C - 6°C (2.7°F – 10.8°F) by 2100, which is almost double the previous IPCC prediction.

Consensus is beginning to build regarding what can and should be done to address this accelerating trend. Even respected business publications like *The Economist* and the *Harvard Business Review*, for example, have concluded that global warming should be taken seriously:

[T]he balance of the evidence suggests that global warming is indeed happening; that much of it has recently been man-made; and that there is a risk of potentially disastrous consequences. ... The time has come to accept that global warming is a credible enough threat to require a public-policy response.⁵⁸

Global warming is a problem characterized by uncertainties. ... But as with any other risk, the uncertainty is no excuse for inaction.⁵⁹

Regarding such uncertainty, the respected Pew Center on Global Climate Change made the following critical point in a new report issued about the potential human health impacts of climate change in the United States:

It is critical to keep in mind that uncertainty regarding adverse health outcomes is not the same as the certainty of no adverse outcomes. Given the potential scope and irreversibility of ecosystem changes and consequent effects on human health and society, traditional public health values would urge prudent action to prevent such changes. The possibility of relatively sudden but

⁵⁷ Watson, Robert T., *Presentation to the Sixth Conference of the Parties to the United Nations Framework Convention on Climate Change*, November 13, 2000. See <http://www.ipcc.ch/press/sp-cop6.htm>

⁵⁸ *The Economist*, *What to Do About Global Warming*, p. 22, and *Hotting Up in The Hague*, pp. 81-83, November 18, 2000.

⁵⁹ Packard and Reinhardt, *What Every Executive Needs to Know About Global Warming*, *Harvard Business Review*, July-August 2000, p. 135.

*unpredictable consequences further raises the value of climate change mitigation for health concerns.*⁶⁰

The earth's climate system is extraordinarily complex, and scientific understanding of the extent, timing, and impacts of climate change is still evolving. Nevertheless, our existing understanding is sufficient to warrant concerted, cost-effective action to diminish the potentially dramatic impacts of climate change on human and ecological health, economic activity, food security, water resources and physical infrastructure.

Among the most important greenhouse gases are CO₂, methane, nitrous oxide, and ozone. NASA scientist Dr. James Hansen and colleagues recently reported that the rapid global warming experienced in recent decades may have been caused largely by other greenhouse gases than CO₂. However, these scientists still strongly recommended reducing the rate of growth in CO₂ emissions.⁶¹ In addition, they indicated that other combustion-related pollutants associated with power plant and transportation emissions, particularly ozone (see Chapter 4) and black carbon (a form of airborne particulate matter; see Chapter 3), should be reduced as expeditiously as possible throughout the world.

Historical analyses indicate that New Hampshire's temperature has increased significantly over the past several decades,⁶² and current climate models predict that this trend will continue. Moreover, temperatures in this country are projected to increase much more than the average global increase⁶³ due, for example, to reduced amounts of reflective winter snow cover. Field surveys show that snow cover over the Northern Hemisphere land surface since 1988 has been consistently below averages over the last quarter century, with an annual mean decrease in snow cover of about 10 percent over North America. These changes have been linked to the observed increases in temperature.⁶⁴

Given these disproportionate impacts, areas like New Hampshire stand to be much more acutely affected than other areas of the globe. Rising sea levels due to thermal expansion of the oceans (already 10-20 centimeters higher over the last century⁶⁵), combined with the natural subsidence of land along the coast, could submerge low-lying coastal areas, infuse salt water into coastal aquifers, dramatically exacerbate coastal erosion, and wreak havoc with the State's seacoast infrastructure (e.g., water supply systems, wastewater treatment,

⁶⁰ Balbus, John M., and Wilson, Mark L., *Human Health & Global Climate Change: A Review of Potential Impacts in the United States*, Pew Center on Global Climate Change, December 2000, p. iv. See http://www.pewclimate.org/projects/human_health.pdf

⁶¹ Hansen, James et al., *Global Warming in the Twenty-first Century: An Alternative Scenario*, Proceedings of the National Academy of Sciences, Vol. 97, Issue 18, 9875-9880, August 29, 2000. See <http://www.pnas.org/cgi/doi/10.1073/pnas.170278997>

⁶² New Hampshire Department of Environmental Services, *Global Warming/Climate Change*, 2000. See http://www.des.state.nh.us/ard/climate_change.htm

⁶³ U.S. National Assessment Synthesis Team, U.S. Global Change Research Program, *Climate Change Impacts on the United States: The Potential Consequences of Climate Variability and Change*, 2000. See <http://www.usgcrp.gov>

⁶⁴ Gleick, Peter H., *Water: The Potential Consequences of Climate Variability and Change for the Water Resources of the United States*, Executive Summary, Pacific Institute for Studies in Development, Environment, and Security, September 2000. See <http://www.pacinst.org/naw.html>

⁶⁵ U.S. Department of the Interior and the Pacific Institute for Studies in Development, Environment, and Security, *New Report Suggests that Climate Change May Have Serious Impacts on National Water Resources*, Press Release, December 15, 2000. See <http://www.pacinst.org/naw.html>

sewer systems, roads, bridges, seawalls, communications systems, etc.). Property and casualty insurers, particularly large global reinsurance firms, are quite concerned about the prospect of widespread damage to private infrastructure (i.e., homes, businesses, vehicles, etc.) as well as public infrastructure, and are already conducting “catastrophe modeling” to better assess their risks and to establish appropriate premiums. This is difficult because the insurers assess future risks based on past experience. As one recent study commissioned by the U.S. Department of the Interior concluded, however:

*The United States has hundreds of billions of dollars invested in dams, reservoirs, aqueducts, water-treatment facilities, and other concrete structures. These systems were designed and for the most part are operated assuming that future climatic and hydrologic conditions will look like past conditions. We now know this is no longer true.*⁶⁶

The same report offers several other concerns about water-related impacts. Areas with a substantial snowpack will experience major changes in the timing and intensity of spring runoff. Lakes and ponds are very sensitive to a wide array of changes in climate, since even small changes in climate can produce large shifts in lake levels and salinity. In addition, increased lake and pond temperatures would stress cold-water fish (e.g., trout and salmon), increase nutrient cycling and productivity (i.e., enhance eutrophication), lower dissolved oxygen (upon which fish depend), and degrade water quality. Moreover, not all effects relate to natural ecosystems; climate change can be expected to play a role in power production from conventional fossil fuel and nuclear power plants by raising cooling water temperatures and reducing plant efficiencies. In some circumstances, higher cooling water temperatures will constrain plant operations.⁶⁷

Figure 7-2 illustrates the potential impact of three scenarios of sea level rise on Hampton Harbor in Hampton, New Hampshire.⁶⁸ These scenarios were modeled in 1995, and using the assumptions available at that time regarding the likely magnitude climate change, Titus and Narayan assessed the probability of the three sea level rise scenarios as 50 percent for an increase of 1.56 feet, 5 percent for an increase of 2.91 feet, and 1 percent for an increase of 7.26 feet. In light of the IPCC’s near doubling of its best estimate of the expected magnitude of warming, however, remodeling these scenarios today would undoubtedly indicate a much higher probability for each of the three scenarios. In addition, certain threshold events may become more probable, and non-linear changes and surprises should be anticipated, even if they cannot be predicted.⁶⁹

Our sandy beaches along the New Hampshire coastline will be affected by a combination of sea level rise and more frequent and severe coastal storms. As was the case in California during the 1998 El Nino, entire beaches can be destroyed and or heavily damaged, requiring

⁶⁶ Gleick, Peter H., *Water: The Potential Consequences of Climate Variability and Change for the Water Resources of the United States*, Executive Summary, Pacific Institute for Studies in Development, Environment, and Security, September 2000. See <http://www.pacinst.org/naw.html>

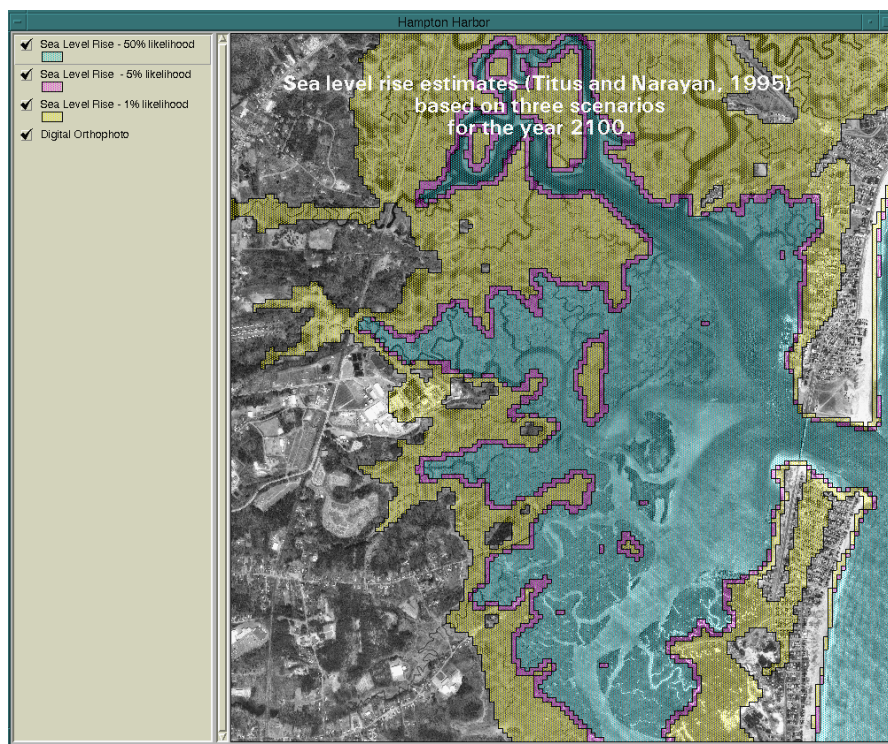
⁶⁷ Ibid.

⁶⁸ Titus, James G., and Vijay Narayan, *The Probability of Sea Level Rise*, EPA Document 230-R95-008, 1995.

⁶⁹ Gleick, Peter H., *Water: The Potential Consequences of Climate Variability and Change for the Water Resources of the United States*, Executive Summary, Pacific Institute for Studies in Development, Environment, and Security, September 2000. See <http://www.pacinst.org/naw.html>

massive expenditures of public funds to protect roads, parks, and private property, and to restore the coastal beaches which are so important to tourism and recreation.

FIGURE 7-2. Potential Impact of Sea Level Rise at Hampton Harbor, Hampton, New Hampshire



Source: Titus and Narayan, 1995

Warmer temperatures would also exacerbate atmospheric air pollution, extreme weather events like those experienced recently (e.g., more hurricanes, heat waves, etc.), and the spread of vector-borne diseases.⁷⁰ The recent northward migration of the West Nile virus to New Hampshire may be evidence that this spread is already underway.

In addition, New Hampshire's habitat could become unacceptable for such economically crucial native species as sugar maples, white birch, trout, and lobster. In several climate simulations, New Hampshire's existing conifer forests largely disappear over the next 70-100 years, and much of the State's northern hardwood forests (i.e., maple, birch, and beech) are replaced by more temperature-tolerant hardwoods (e.g., oak and hickory) or savanna.⁷¹

Figure 7-3 illustrates two of these scenarios, modeled as part of the 2000 National Assessment.⁷² The number of optimal sap flow days for maple sugaring could drop from 18

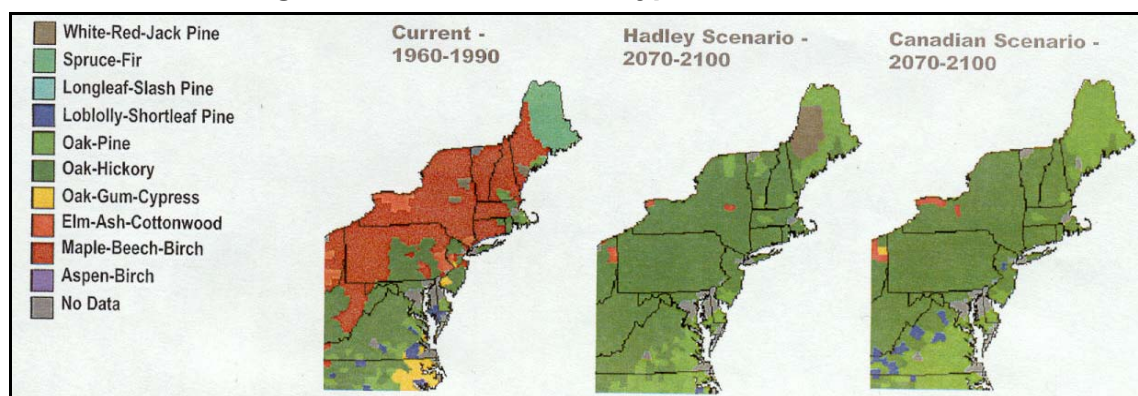
⁷⁰ Intergovernmental Panel on Climate Change, *Climate Change 1995: An IPCC Assessment*, Cambridge University Press: New York, 1996.

⁷¹ Environmental Defense Fund (now Environmental Defense), *Seasons of Change: Global Warming and New England's White Mountains*, 1997, p.12.

⁷² U.S. National Assessment Synthesis Team, U.S. Global Change Research Program, *Climate Change Impacts on the United States: The Potential Consequences of Climate Variability and Change*, 2000, p. 45. See <http://www.usgcrp.gov>

to between 11 and 15, a drop of 17–39 percent.⁷³ The warming associated with a doubling of CO₂ could lead to a loss of trout habitat in New Hampshire ranging from 50–99 percent for brook trout and brown trout to 100 percent for rainbow trout.⁷⁴ Similarly, lobster populations are associated with cooler waters and warming is thus likely to promote northward migration of the lobster population.⁷⁵

FIGURE 7-3. Changes in Dominant Forest Types Under Two Climate Scenarios



Source: U.S. Global Change Research Program

Our recreational industries (skiing, foliage, water sports, etc.) would be dramatically impacted as well. One analysis suggested that the number of winter season days (days with high temperatures below freezing between November 1 and April 30) in Pinkham Notch would drop from the 1956–1995 average of 165 to between 130 and 149, a drop of 10–21 percent.⁷⁶ Last year set a New Hampshire record for the longest number of days between the last appreciable spring snowfall and the next winter’s first appreciable snowfall. It is particularly noteworthy that all of the above assessments (i.e., regarding woodlands, trout, maple sap, and ski days) were done *before* IPCC’s recent warming prediction which nearly doubled expected temperature.

Although space constraints in this document prohibit exhaustive discussion of the impacts of climate change on human health, agriculture, forests, recreation, coastal areas, water resources, ecosystems, real estate, and infrastructure in New Hampshire, such issues are covered extensively at the websites listed below. The first three are specific to New Hampshire; the fourth applies to the Northeast as a whole.

<http://www.des.state.nh.us/factsheets/ard/ard-23.htm>

<http://www.epa.gov/globalwarming/impacts/stateimp/newhampshire/index.html>

http://www.epa.gov/oppeoeel/globalwarming/publications/impacts/state/nh_impct.pdf

<http://www.gcrio.org/nationalassessment/overpdf/5NE.pdf>

⁷³ Environmental Defense Fund (now Environmental Defense), *Seasons of Change: Global Warming and New England’s White Mountains*, 1997, p. 24.

⁷⁴ Ibid, p. 22.

⁷⁵ U.S. National Assessment Synthesis Team, U.S. Global Change Research Program, *Climate Change Impacts on the United States: The Potential Consequences of Climate Variability and Change*, 2000, p. 45. See <http://www.usgcrp.gov>

⁷⁶ Environmental Defense Fund (now Environmental Defense), *Seasons of Change: Global Warming and New England’s White Mountains*, 1997, p. 19.

7.2. Existing Programs and Commitments

Few states currently have regulations in place specifically limiting emissions of greenhouse gases from fossil fuel-fired power plants (or any other source category) at this time, though New Jersey, Oregon, and Massachusetts have undertaken steps in this direction. Nevertheless, having grasped the potential ramifications of climate change relatively early, New Hampshire has been a leading influence on this issue. New Hampshire was the first state, for instance, to employ a full-time climate change specialist. In 1999, New Hampshire conceived and legislatively created a voluntary Greenhouse Gas Emission Reduction Registry, a groundbreaking development that caught national attention,⁷⁷ and was echoed by Wisconsin and California in 2000. Other states are considering similar legislation, and discussions are underway to build greater multi-state uniformity into various registry initiatives in order to increase the incentive they offer to reduce CO₂ emissions. Interstate reciprocity agreements – currently under consideration – could lead to the first widespread GHG trading in the United States. Already, several New Hampshire companies have indicated that they plan to make CO₂ reductions and register them with the State.

In addition, many New Hampshire sources have undertaken steps that substantially reduce CO₂ emissions, generally for economic or efficiency reasons, which illustrates that lower CO₂ emissions often go hand-in-hand with economic competitiveness. For example, for years methane (a greenhouse gas 23 times more potent than CO₂) has been captured at New Hampshire's larger landfills and burned to generate electricity, reducing climate impacts as well as operators' electric bills. Similarly, several co-generation projects are already underway in New Hampshire's north country. Using a single boiler or turbine (often fueled with natural gas), co-generation combines the production of heat (steam) and electric power for companies – such as paper manufacturers – that require steam in their manufacturing processes. Co-generators – and the environment – thus get a two-for-one benefit compared to separately generating steam and also generating or purchasing electric power.

Further, with the assistance of EPA, New Hampshire has commenced a “Local Impact Assessment Project (LIAP)” to better comprehend and assess the likely impacts of climate change on the State. The LIAP will be informed by the best available science, and advised by both area scientists and stakeholders from key constituencies. New Hampshire has also completed a greenhouse gas emissions inventory and will soon publish an action plan for reducing greenhouse gas emissions in the State.

7.3. Reasons for Further Action

On top of the numerous threats noted above, sound public policy practices also prompt attention to greenhouse gas emission reductions. For example, the National Academy of Public Administration (NAPA) just completed an exhaustive report, funded by Congress, about how EPA and Congress should transform environmental governance by developing and deploying approaches to environmental protection that can deliver measurable environmental

⁷⁷ Dernbach, John, *Moving the Climate Change Debate From Models to Proposed Legislation: Lessons From State Experience*, Environmental Law Reporter, Special Issue, 2000. See <http://www.eli.org>

results more effectively and efficiently.⁷⁸ This report to Congress suggests that EPA narrow its current broad environmental focus to three priority items: reversing the accumulation of greenhouse gases, reducing nutrients in watersheds (see Chapter 6), and reducing ozone smog (see Chapter 4).

This conclusion is particularly relevant to New Hampshire, where our quality of life depends heavily on the environment. Our tourism and natural resource industries hinge on forest and natural habitats, adequate precipitation, definitively changing seasons, good water and air quality, etc. Perhaps surprisingly, our “New Economy” industries (e.g., software, networking, etc.) also have a strong economic interest in environmental quality. As a recent report by NetworkNH (a consortium of technologically-oriented New Hampshire companies) stated:

In an economy where physical assets are not as important as they used to be, where intellectual assets dominate, where business can be conducted from anywhere to anywhere, it would seem that place should not matter; in fact, it matters more. ... Places – through the quality of life they offer – matter because entrepreneurs and highly skilled and sought-after workers want to live in areas with educational, cultural, natural and civic amenities.⁷⁹

Climate change threatens these cornerstones, so inaction regarding climate change puts New Hampshire’s quality of life at risk.

Further, the use of high technology and energy efficiency equipment is one of the most effective approaches to reducing climate-altering emissions. New Hampshire has the highest overall percentage of high technology workers per capita (second-highest behind Colorado in private sector workforce employed in high technology).⁸⁰ As a result, there is good reason to suspect that any concerted regional, national, or international effort to address climate change would enhance market opportunities for New Hampshire’s high technology industries. Concerted climate action thus stands to benefit the State economically as well as environmentally. The analyses done by Hansen, et al.,⁸¹ Lovins,⁸² and Hawken and Lovins⁸³ confirm this assessment, indicating that “there are opportunities to achieve reduced emissions consistent with strong economic growth.”⁸⁴

Concerted climate action is thus necessary to protect or enhance New Hampshire’s environment, its environmentally-dependent recreational and tourism industries, and the State’s high technology sector. State leadership is also necessary to spur concerted action by other states and the federal government because “technologies for improved energy

⁷⁸ National Academy of Public Administration, *Transforming Environmental Protection for the 21st Century*, November 2000. See <http://www.napawash.org/napa/environdotgov.pdf>

⁷⁹ NetworkNH, *NH in the 21st Century, Competing in the New Economy*, December 1, 2000, p. 16. See <http://www.network.com>

⁸⁰ Ibid.

⁸¹ Hansen, James, et al., *Global Warming in the Twenty-first Century: An Alternative Scenario*, Proceedings of the National Academy of Sciences, Vol. 97, Issue 18, 9875-9880, August 29, 2000. See <http://www.pnas.org/cgi/doi/10.1073/pnas.170278997>

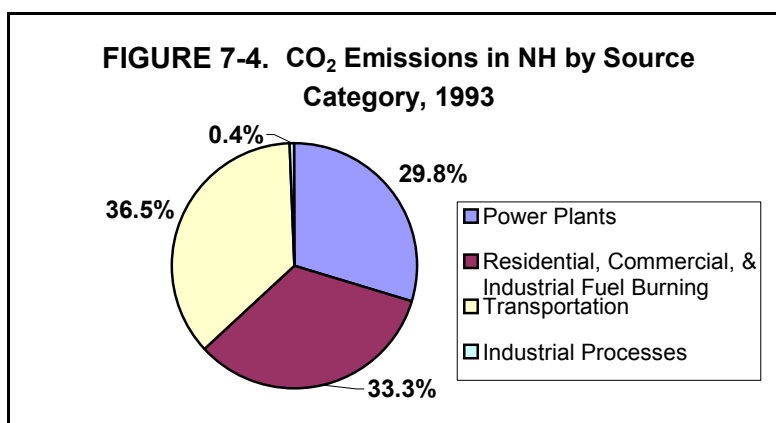
⁸² Lovins, A. & Lovins, H., *Climate: Making Sense and Making Money*, Rocky Mountain Institute, 1997.

⁸³ Hawken, P., Lovins, A. & Lovins, H., *Natural Capitalism*, Little Brown, 2000.

⁸⁴ Hansen, James, et al., *Global Warming in the Twenty-first Century: An Alternative Scenario*, Proceedings of the National Academy of Sciences, Vol. 97, Issue 18, 9875-9880, August 29, 2000, p. 4.

efficiency exist and implementation can be driven by economic self-interest, but governments need to remove barriers that discourage buying of energy efficiency.”⁸⁵ Because such action is clearly in New Hampshire’s interest, the State should undertake aggressive steps to demonstrate the feasibility and effectiveness of greenhouse gas emission reduction opportunities. Encouragingly, the New Hampshire Public Utilities Commission recently took a small but significant step in this direction, approving greater funding for energy efficiency activities in the State.⁸⁶

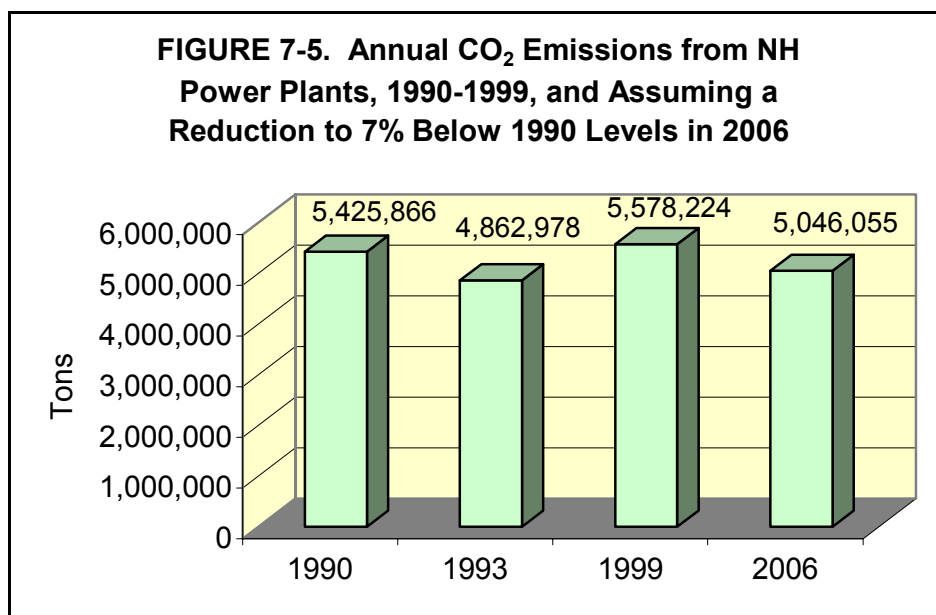
New Hampshire’s 1993 greenhouse gas emissions inventory indicates that coal- and oil-burning power plants are responsible for 30 percent of gross CO₂ emissions in the State (see Figure 7-4). This percentage may be even larger now, because CO₂ emissions from New Hampshire’s power plants have increased by 15 percent since 1993 (see Figure 7-5). The average annual CO₂ emission rate for new, combined cycle power plants burning natural gas is 760 lbs/MWh, while the average annual CO₂ emission rate from New Hampshire’s existing fossil fuel-burning power plants is close to 2,300 lbs/MWh, over three times higher. Due to the significant threats posed by climate change, future federal regulation of CO₂ emissions are only a matter of time, so early action by New Hampshire may enable its sources to gain a competitive advantage by getting ahead of federal action.



Source: DES

⁸⁵ Hansen, James et al., *Global Warming in the Twenty-first Century: An Alternative Scenario*, Proceedings of the National Academy of Sciences, Vol. 97, Issue 18, 9875-9880, August 29, 2000, p 4. See <http://www.pnas.org/cgi/doi/10.1073/pnas.170278997>

⁸⁶ New Hampshire Public Utilities Commission, Order Nos. 23,574, *Energy Efficiency Programs*, and 23,575, *Allocation of System Benefits Charge*, November 1, 2000. See <http://www.puc.state.nh.us/>



Source: US EPA and DES

In order to respond to the numerous threats that climate change poses to New Hampshire, and to establish the state leadership demonstrably needed on this issue, the NHCPS recommends a CO₂ emissions cap based on a 7 percent reduction from 1990 baseline CO₂ emissions from New Hampshire's existing coal- and oil-burning power plants, implemented using market-based measures. The NHCPS recommends that this reduction requirement for CO₂ take effect in 2006.

This CO₂ emission reduction will provide multiple additional benefits, including human health gains through less acid deposition (see Chapter 2), less particulate matter formation (see Chapter 3), less ground level ozone (see Chapter 4), enhanced ecosystem integrity, less eutrophication and nitrification of waterbodies (see Chapter 6), better visibility and enhanced scenic quality (see Chapter 8), and the attendant economic benefits to recreational, high technology, and natural resource industries (see Chapter 12). They will also help level the competitive playing field between "grandfathered" power plants and new facilities, as called for in New Hampshire RSA 374-F:3, VIII.

In addition, achieving CO₂ emissions reductions by reducing generation from coal- and oil-burning power plants will have simultaneous "co-benefit" effects, dramatically reducing emissions of SO₂, NO_x, mercury, and other toxic compounds as well as CO₂. Fuel switching has similarly significant co-benefit effects. Energy efficiency measures – which avoid having to generate electricity in the first place – are most effective means of reducing air pollution, since they avoid all emissions of all pollutants, and simultaneously save users the money they would have spent to buy the electricity.

Since other source categories – notably transportation sources – are also substantial CO₂ emitters, additional pollution reductions are also necessary from these sources. Some of DES's efforts in pursuit of CO₂ reductions from other emission sources are described in Chapter 10. The *New Hampshire Climate Change Action Plan* and the *Clean Air Strategy* for

New Hampshire, both of which will be published in the next few months, present a comprehensive picture of DES's air pollution reduction strategies.

8. REGIONAL HAZE

8.1. Characterization of the Problem

New Hampshire's White Mountains are home to the highest peaks in the northeastern United States. The beauty of these mountains has drawn tourists to the northern part of New Hampshire for almost our entire history as a nation. Whether the view is from a nearby town to a rugged mountaintop, or from a hiker's mountain top vantage point, clear vistas are an essential component of the New Hampshire recreation experience. Simply put, our tourism and recreational industries depend on beautiful scenery and the ability to see it.

Clouds and/or haze often compromise visibility in the Northeast. While the cloudiness is a natural occurrence in the mountains that under certain conditions can actually enhance the beauty of the region, haze is not. On a hazy day, visibility from the White Mountains can drop from about 100 miles to just a few miles, turning idyllic valley-to-mountain outlooks and mountaintop vistas into visual disappointments. Depending on weather conditions, natural visibility on a clear day in the White Mountains is about 75 to 100 miles. Under optimum conditions, visibility from the summit of Mt. Washington may even reach up to 135 miles, including four States and Canada. Unfortunately, regional haze has diminished annual average visibility in eastern national parks and wilderness areas to about 25 percent of natural conditions.

Figure 8-1 illustrates how dramatically regional haze can affect viewers' enjoyment. These photographs of Mt. Jefferson in the Presidential Range of New Hampshire's White Mountain National Forest, taken from Camp Dodge by the Appalachian Mountain Club, show the same view on one of the clearest – and one of the haziest – summer days.

FIGURE 8-1. Visibility Impairment in New Hampshire's White Mountains: Mt. Jefferson photographed from AMC's Camp Dodge at near natural conditions (6 deciviews) and at 90+ percentile haze (28 deciviews)

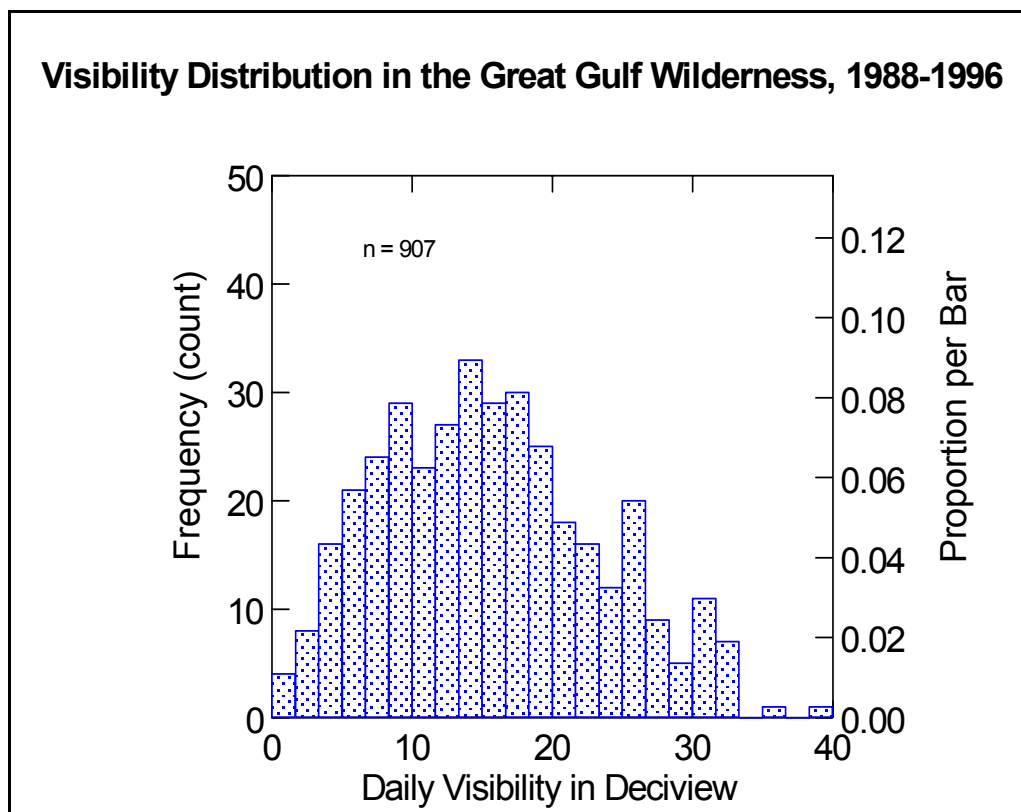


Source: Appalachian Mountain Club

“Deciviews” are a measure of visible distance, with higher values representing declining visibility. Figure 8-2 shows that compromised visibility is, unfortunately, not at all unusual

in the Great Gulf Wilderness of New Hampshire's White Mountain National Forest.⁸⁷ Approximately one day each week has visibility as poor as the right-hand photograph above, but only about two days each month are as good as the left-hand photograph above.

FIGURE 8-2. Distribution of Average Daily Visibility Measurements in New Hampshire's Great Gulf Wilderness, 1988-1996



Source: Bruce Hill

Visibility is obstructed by tiny particles and gases, most of which are too small to be seen with the naked eye. They are, however, big enough to block or interfere with the path of visible light. In the Northeast, the vast majority of visibility reduction comes from sulfate particles; the same fine particles that are principally responsible for acid rain, PM_{2.5}, lung damage, and premature death. Sulfates originate primarily from SO₂ emissions from coal-burning power plants and can then be transported over long distances. According to EPA, power plants are responsible for over two-thirds of the sulfate particles in the United States.

Monitoring at Acadia National Park in Maine and Lye Brook Wilderness in Vermont indicates that sulfate accounts for 70-85 percent of the particles impairing visibility. Organic carbon, nitrates, elemental carbon, and crustal materials make up most of the remaining particle content (in declining order of importance). Based on IMPROVE (Interagency Monitoring of PROtected Visual Environments) monitoring data from throughout the Eastern

⁸⁷ Hill, L. Bruce, et al., *Visitor Perceptions and Valuation of Visibility in the Great Gulf Wilderness, New Hampshire*, USDA Forest Service Proceedings RMRS-P-O, 2000.

United States, sulfate is by far the most dominant visibility-impairing component, typically accounting for 80-90 percent of the impairment on the haziest 20 percent of all days.

8.2. Existing Programs and Commitments

In June 1999, EPA issued final regional haze regulations for protection of visibility in 156 national parks and wilderness areas, including two in New Hampshire.⁸⁸ Key elements of this rule include:

- It applies to all 50 states in order to reduce the transport of fine particles;
- It requires States to establish “reasonable progress” targets to improve visibility on the haziest days (and to ensure no degradation on the clearest days) with an overall goal of reaching natural background conditions in 60 years or sooner;
- Its first phase will cover 10 to 15 years, with a reassessment in 2018 and every 10 years thereafter;
- It requires state implementation plans (SIPs) to include three basic elements regarding installation of “best available retrofit technology” (BART): (1) a list of applicable sources; (2) a regional analysis of the cumulative emissions reductions and changes in visibility that would result from installing BART on these sources; and (3) the emissions limits for each applicable source (or an alternative approach such as a trading program that could achieve greater visibility improvement than installing controls on a source-by-source basis);
- It expands the existing monitoring network for Class I visibility areas from 30 to 108 sites; and
- It allows for groups of States to undertake visibility enhancement efforts on a regional basis.

Unfortunately, in August 1999, the American Corn Growers Association (ACGA) and others challenged this rule in the U.S. Court of Appeals for the District of Columbia, claiming that EPA failed to consider the adverse impact it would have on U.S. farmers.⁸⁹ ACGA claims that the rule is not “regional,” since it impacts farmers in nearly every state, not just those with pristine Class I areas to protect. ACGA is also concerned that dust from soil tillage in the spring and crop burning in autumn might have to be curtailed.

The New Hampshire Attorney General’s Office announced September 29, 1999 that the state would intervene in this litigation on behalf of the EPA, because EPA’s regional haze rule would reduce the pollution that drifts from Midwestern and Southeastern states into New Hampshire. This, in turn, would help prevent the haze that limits visibility in the State’s Class I areas. As Governor Shaheen said at that time, “Visibility is not just about aesthetics,” it has a “dramatic” economic effect on tourism, which is the state’s second largest industry.

⁸⁸ U.S. Environmental Protection Agency, Fact Sheet “*Final Regional Haze Regulations for Protection of Visibility in National Parks and Wilderness Areas*”, June 2, 1999. See http://www.epa.gov/ttncaaa1/t1/fact_sheets/hazefs2.pdf

⁸⁹ American Corn Growers Association v. EPA, D.C. Circuit, No. 99-1348, August 30, 1999.

8.3. Reasons for Further Action

In 1997, EPA adopted a regional haze program that mandates state implementation plans (SIPs) to improve visibility in 156 mandatory Federal Class I areas, including the Great Gulf Wilderness Area and the Presidential Range - Dry River Wilderness Areas in New Hampshire's White Mountains. The goal of this program is to progressively reduce emissions that impair visibility in a way that returns each Class I area to "background conditions" or natural visibility within 60 years. This program mandates visibility improvements on the haziest 20 percent of all days, while maintaining visual quality on the clearest days. Like others, the State of New Hampshire incurred obligations under this rule; these obligations will be largely or entirely met by the provisions of the NHCPs.

According to a recent Clean Air Task Force report, the value of eliminating power plant haze may be over \$7 billion dollars per year. This study, conducted by Abt Associates, also indicated that small increases in visits to our national parks could result in significant increases in revenues and jobs. The analysis showed that local economies benefit from the increased tourism that is likely when visibility is improved. For example, if visibility improvements increased park visitation by 25 percent, the potential annual benefit to a local community could range (depending on the park) from \$13 million and 390 new jobs, to \$320 million and 4,188 new jobs. Revenues to national parks and their concessionaires would also be boosted by an increase in visits. A 25 percent increase in visitors could yield approximately \$30 million in additional park fees and \$160 million in additional concession sales.⁹⁰

Substantial SO₂ and NO_x emissions reductions from coal- and oil-burning power plants are necessary to improve visibility. Therefore, the NHCPs recommends a 75 percent further reduction in annual SO₂ emissions beyond current levels, implemented using market-based measures and an emissions cap based on 3.0 lbs/MWh, and a 70 percent further reduction in annual NO_x emissions beyond current levels, implemented using market-based measures and an emissions cap based on 1.5 lbs/MWh, applicable to New Hampshire's existing coal- and oil-burning power plants. The NHCPs recommends that these reduction requirements for SO₂ and NO_x take effect in 2006.

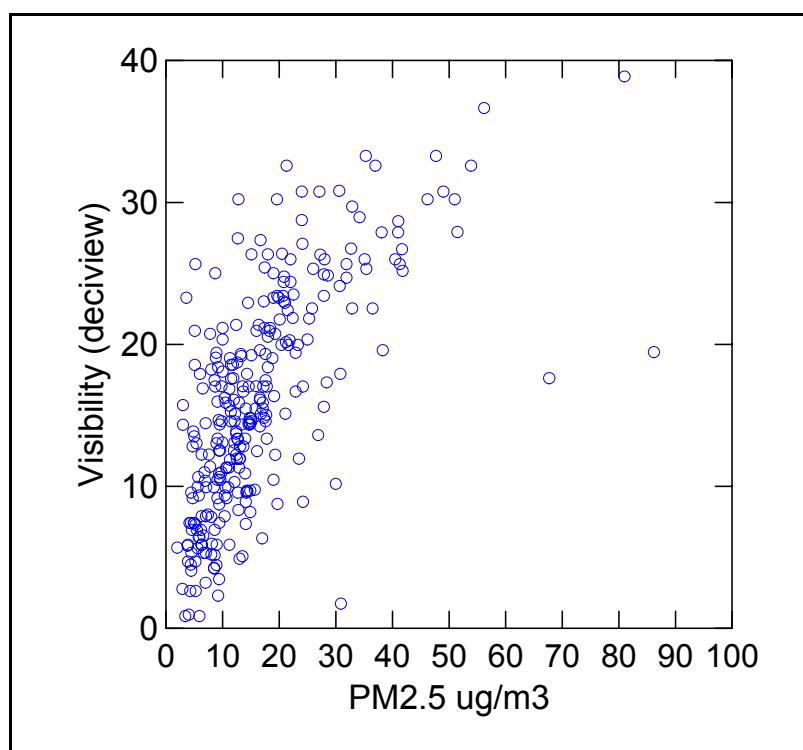
These SO₂ and NO_x reductions will provide multiple additional benefits beyond reducing regional haze. These benefits include human health gains through less acid deposition (see Chapter 2), less particulate matter formation (see Chapter 3), and less ground level ozone (see Chapter 4); enhanced ecosystem integrity; less mercury deposition (see Chapter 5), less eutrophication and nitrification of waterbodies (see Chapter 6), less climate change because one form of NO_x (nitrous oxide or N₂O) is also a greenhouse gas (see Chapter 7), and the attendant economic benefits to recreational and natural resource industries (see Chapter 12). These reductions will also help level the competitive playing field between "grandfathered" power plants and new facilities, as called for in New Hampshire RSA 374-F:3, VIII.

⁹⁰ Clean Air Task Force, *Out of Sight: Haze in our National Parks; How Power Plants Cost Billions in Visitor Enjoyment*, August 24, 2000. See <http://cta.policy.net/proactive/newsroom/release.vtml?id=19060>

In addition, many measures to reduce SO₂ and NO_x emissions have simultaneous “co-benefit” effects, reducing other pollutants. Derating and fuel switching dramatically reduce emissions of SO₂, NO_x, PM_{2.5}, CO₂, mercury, and other toxic compounds as well as. Selective catalytic reduction (SCR) technology apparently helps reduce mercury emissions. Energy efficiency measures – which avoid having to generate electricity in the first place – are most effective means of reducing air pollution, since they avoid all emissions of all pollutants, and simultaneously save users the money they would have spent to buy the electricity.

Figure 8-3 illustrates this co-benefit effect as it applies to regional haze and PM_{2.5}.⁹¹ As PM_{2.5} concentrations increase from single digits to 20-30 micrograms per cubic meter, visibility rapidly declines to the levels shown in the right-hand photograph in Figure 8-1. As a result, solving the PM_{2.5} problem will have the co-benefit of dramatically improving visibility.

FIGURE 8-3. Relationship of Visibility in Deciviews to Fine Particulate Mass (PM_{2.5}) in New Hampshire’s Great Gulf Wilderness



Source: Bruce Hill

Other source categories – notably transportation and industrial sources – are also substantial NO_x emitters and, to a much lesser degree SO₂ emitters, so additional pollution reductions are

⁹¹ Hill, L. Bruce, et al., *Visitor Perceptions and Valuation of Visibility in the Great Gulf Wilderness, New Hampshire*, USDA Forest Service Proceedings RMRS-P-O, 2000.

also necessary from these sources. Several of DES's efforts in pursuit of SO₂ and NO_x reductions from other emission sources are described in Chapter 10.

Direct regulation regarding regional haze has not been recommended in the NHCPS because, regional haze problems arise indirectly through atmospheric transformations involving SO₂ and NO_x, and the NHCPS does recommend limiting emissions of these pollutants. If, however, after implementation, the NHCPS's anticipated benefits regarding regional haze do not materialize, it may be necessary to regulate this pollution problem directly.

9. TOXIC AIR POLLUTANTS

9.1. Characterization of the Problem

Toxic air pollutants are those compounds which, at sufficient concentrations and exposure, are known or suspected to cause cancer or other serious health effects, such as reproductive effects or birth defects, or to cause adverse environmental effects. In general, the toxic air pollutants that are of greatest concern are those that (1) are released into the air in large enough amounts to create a risk to human health, and (2) have the potential to reach many people.

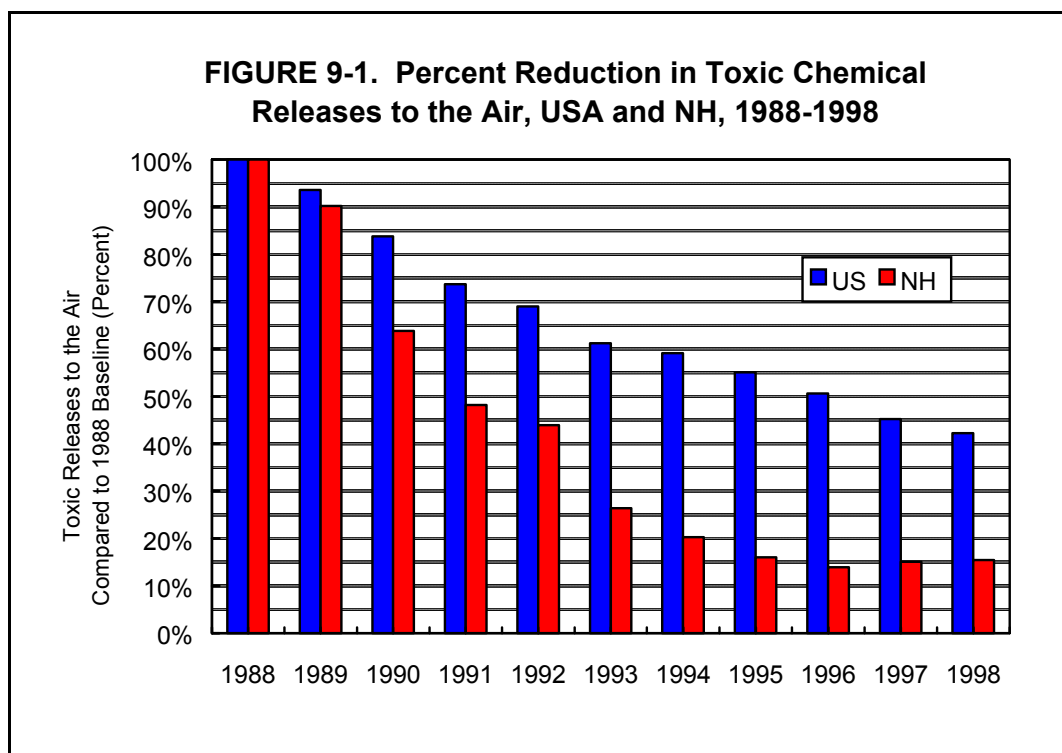
Toxic air pollutants may exist as particulate matter or as vapors. Examples of gaseous toxic air pollutants include benzene, toluene and xylenes, which are found in gasoline; perchloroethylene, which is used in the dry cleaning industry; and methylene chloride, which is used as a solvent by a number of industries. Examples of air toxics typically associated with particulate matter include heavy metals such as mercury, cadmium, chromium, and lead compounds; and semi-volatile organic compounds such as polycyclic aromatic hydrocarbons (PAHs) that are generally emitted from the combustion of fossil fuels and wastes.

9.2. Existing Programs and Commitments

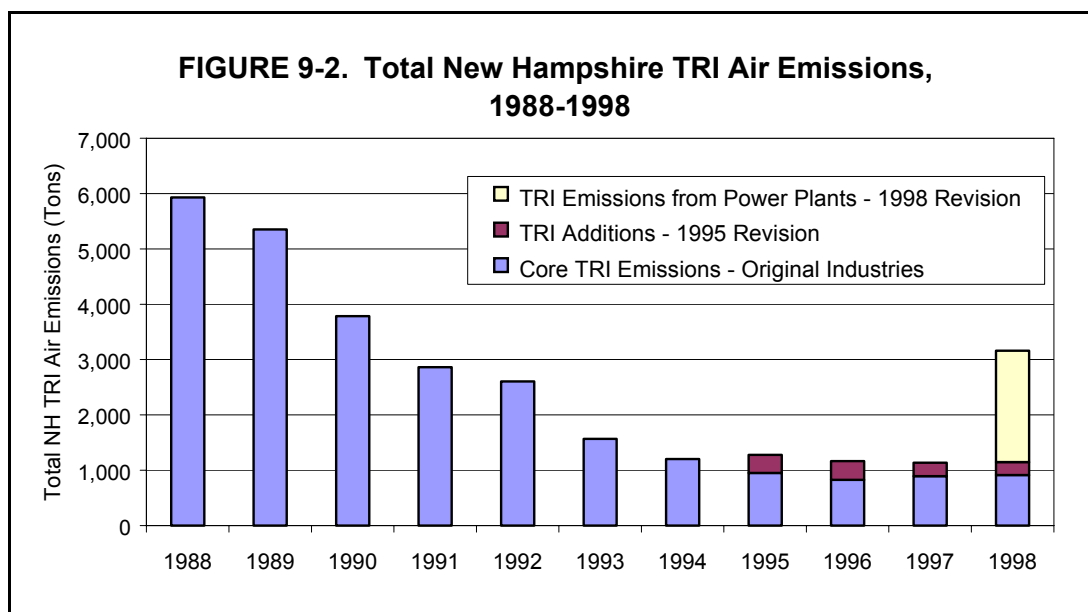
Due principally to their public health risks, air toxics were included by the New Hampshire Comparative Risk Project on its list of 53 environmental risks facing the State.⁹² Toxic air pollution was not rated as serious as some environmental risks, however, due to the fact that toxics are well regulated in New Hampshire, and the State has been a consistent leader in reducing toxic air emissions. For the last decade, for instance, EPA has been collecting information about toxic emissions from large manufacturing operations through its Toxic Release Inventory (TRI) program. As Figure 9-1 shows, New Hampshire's toxic emission reduction percentages have substantially outpaced the national average. For much of the last decade, New Hampshire has been the top state in the country in reducing toxic air emissions.

For 1998 (the most recent year reported), the TRI program was modified to require reports on emissions from power plants as well as manufacturers. New Hampshire's existing coal- and oil-burning facilities leapt to the top of the list of TRI emitters in the state (as such facilities did in most states). Figure 9-2 illustrates New Hampshire's TRI reductions in absolute amounts. This stacked-bar figure illustrates the original TRI reporting set (i.e., the original industries and chemicals) at the bottom; the chemicals added by EPA's 1995 TRI revision in the middle; and power plant TRI emissions – first added for 1998 emissions – at the top. Table 9-1 lists the specific toxic air pollutants emitted by New Hampshire's coal- and oil-burning power plants.

⁹² New Hampshire Comparative Risk Project, *Report of Ranked Environmental Risks in New Hampshire*, 1 May 1997. See http://www.scorecard.org/comp-risk/report.tcl?fips_state_code=33



Source: US EPA



Source: US EPA

**TABLE 9-1. 1998 Toxic Release Inventory (TRI) Data
(Tons of Air Emissions)**

| Toxic Air Pollutant | Toxicity Class* | Merrimack Station | Schiller Station | Newington Station |
|---------------------|-----------------|-------------------|------------------|-------------------|
| Ammonia** | II | 2.2 | n/a | n/a |
| Barium | II | 0.36 | 0.36 | 0.01 |
| Chromium | I | 0.11 | n/a | n/a |
| Hydrochloric Acid | I | 1250 | 270 | 16 |
| Hydrogen Fluoride | I | 75 | 24 | 4.3 |
| Manganese | II | 0.18 | n/a | n/a |
| Nickel | I | 0.085 | 0.07 | 0.27 |
| Sulfuric Acid | I | 220 | 70 | 80 |
| Zinc | II | 0.14 | n/a | n/a |

* – NH Air Toxics Control Program has three toxicity classes, I (high) to III (low)

** – From ammonia “slip” associated with NO_x emission controls

n/a – Not emitted or not emitted above TRI reporting thresholds

Source: US EPA

EPA has identified 188 hazardous air pollutants (HAPs) from major stationary sources and regulates emissions of these compounds. The *New Hampshire Air Toxics Control Program* regulates the emissions of over 750 toxic air pollutants, including the 188 federal HAPs, from all stationary sources. Prior to adoption of the *New Hampshire Air Toxics Control Program* by the legislature in 1987, air pollution regulations were designed primarily for emissions of “criteria” pollutants resulting from fuel combustion processes (i.e., ozone, particulates, NO₂, SO₂, lead, and carbon monoxide); emissions of toxic chemicals were essentially unregulated.

New Hampshire’s *Air Toxics Control Act of 1987* was designed primarily to protect public health by addressing unregulated sources of these emissions. At the time, it was recognized that fuel combustion also releases toxic chemicals, but it was thought that these emissions were controlled indirectly through existing regulations on criteria pollutant emissions. In order to reduce the regulatory burden and avoid duplicative requirements for businesses and operations that were already subject to criteria pollutant regulations, this statute (and its implementing regulations) exempted several activities, including the combustion of virgin petroleum products, coal, natural gas, and wood at power plants and other stationary sources.

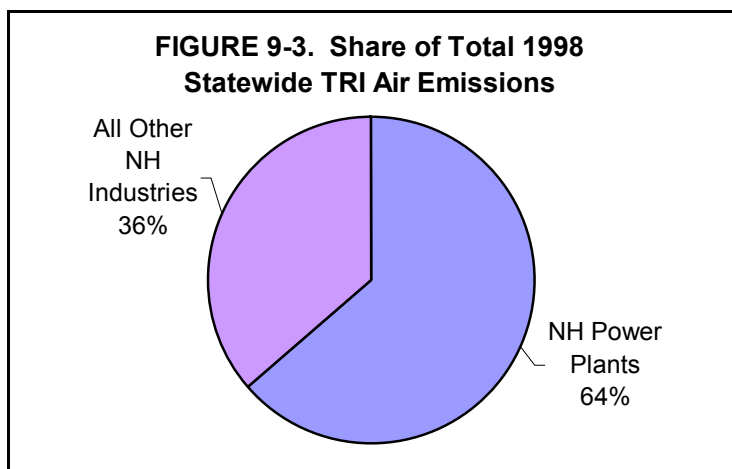
While power plant boiler emissions are exempt from this regulation, other processes at these facilities are not. For example, fugitive dust generated from storage and handling of coal and fly ash is subject to it. These materials contain several regulated toxic air pollutants, and since these operations are not directly part of the combustion processes exempted, their emissions are regulated. In addition, if DES identifies emissions of a specific regulated toxic air pollutant from an exempt source as a potential for concern, that pollutant can be addressed individually. For example, the *New Hampshire Mercury Reduction Strategy* identified power plants as significant sources of mercury emissions in the State, and DES is now addressing these emissions outside of the *Air Toxics Control Act*. This effort is being undertaken pursuant to the *Mercury Emissions Reduction and Control Act* (RSA 125-M:3, III.), which

asks DES to “evaluate the technical and economic feasibility of establishing a mercury emission limit for coal-burning electricity generation plants.” Power plant emissions are also being examined as part of the *New Hampshire Dioxin Reduction Strategy*.

Power plants are subject to federal laws regarding hazardous air pollutants, although few have been promulgated to date. EPA is in the processes of setting federal standards for emissions of hazardous air pollutants from electric power plants, and if these regulations are finalized, all affected New Hampshire sources will be subject to them as well.

9.3. Reasons for Further Action

Of all stationary sources in New Hampshire, power plants emit the largest quantity of toxic air pollutants (see Figure 9-2) by far. In fact, Figure 9-3 illustrates that the amount of toxic emissions from power plants is almost twice as great as emissions from all other New Hampshire TRI sources combined. Although some of the toxic pollutants emitted by power plants are lower in toxicity than many other HAPs, and none result in violations of regulatory ambient air limits, their sheer volume calls for a reasonable effort to be made to reduce these emissions.



Source: US EPA

Implementation of the NHCPS is expected to encourage lower HAP emissions from power plants through cleaner generation (e.g., natural gas) and greater utilization of energy efficiency and conservation measures as a result of allocating SO_2 and NO_x allowances on a generation output basis. This allocation method will minimize the amount of toxic contaminants discharged for a given amount of electricity generated.

Toxic emission reductions will also occur as a co-benefit of many existing and future control devices on power plants. Other strategies to comply with the NHCPS – such as derating and fuel switching – also have substantial co-benefit effects, dramatically reducing emissions of SO_2 , NO_x , CO_2 , mercury, and other toxic compounds simultaneously. Energy efficiency measures – which avoid having to generate electricity in the first place – are most effective means of reducing air pollution, since they avoid all emissions of all pollutants, and simultaneously save users the money they would have spent to buy the electricity.

Other source categories – particularly transportation sources – are also substantial emitters of toxic air contaminants. In fact, most of the hazardous air pollutants that exist in concentrations above health risk screening levels in New Hampshire are emitted from motor vehicles. Additional pollution reductions are also necessary from these sources. Several of DES’s efforts in pursuit of emission reductions from these sources are described in Chapter 10 and in the *Clean Air Strategy* for New Hampshire.

10. OTHER EMISSION REDUCTION INITIATIVES

10.1. Power Plant Initiatives in Other States

While all of the Northeast states have implemented emission reduction programs for electric power plants consistent with the federal Clean Air Act and the OTC NO_x MOU, some states – notably Connecticut, Massachusetts, and New York – have recognized the need for additional reductions at power plants and have recently announced plans and/or regulations for securing substantially greater emission reductions from these sources. Appendix 4 compares the NHCPS to these state plans and other power plant emission reduction proposals from NEGC/ECP, the Clean Air Task Force (an environmental organization), and the Clean Energy Group (a progressive electric industry group, of which Consolidated Edison and Northeast Utilities are members).

Connecticut – In May 2000, Connecticut Governor Rowland signed an executive order requiring the Connecticut Department of Environmental Protection (CT DEP) to develop regulations reducing annual SO₂ emissions from 61 major sources of air pollution – including the state’s fossil fuel-burning power plants – by 30-50 percent from current commitments. The executive order also required CT DEP to reduce annual NO_x emissions from the same facilities by 20-30 percent. CT DEP has developed and adopted regulations to implement Governor Rowland’s executive order. The regulations do not address mercury or CO₂ emissions at this time.

Massachusetts – Following up on an earlier promise, Massachusetts Governor Cellucci announced, also in May 2000, a new program to reduce SO₂ emissions rates by 50 percent by 2006, NO_x emissions rates by 50 percent by 2003, and CO₂ emissions rates to 93 percent of 1990 emission levels by 2006. The Massachusetts Department of Environmental Protection (MA DEP) has proposed regulations to implement Governor Cellucci’s program. Mercury emissions may also be regulated following federal action regarding mercury emitted from power plants.

New York – In October 1999, New York Governor Pataki announced a commitment to reduce SO₂ emissions by 50 percent by 2005 and to implement year-round NO_x emission limits by 2003. The New York Department of Environmental Conservation (NY DEC) is drafting regulations to implement Governor Pataki’s plan. These regulations are not expected to address mercury or CO₂ emissions.

New England Governors Conference and Eastern Canadian Premiers – In June 1998, this transnational group of state and provincial leaders agreed to pursue additional, regional reductions of SO₂ by 50 percent from Clean Air Act Phase II Acid Rain requirements by 2010, and a year-round NO_x emission limits of 0.30 lb/mmBtu (about 3.0 lb/MWh) by 2007. In July 2000, in a separate action to mitigate mercury contamination, NEGC/ECP agreed to pursue overall reductions regionally of 25-50 percent by 2005, and to seek a 60-90 percent reduction from 1995 emission levels from power plants by 2010. The NEGC/ECP has not yet established a plan to reduce emissions of CO₂ from power plants.

Clean Air Task Force (CATF) – This environmental organization seeks aggressive, year-round, output-based limits on “grandfathered” power plants. It targets a 3.0 lb/MWh limit on SO₂ emissions and a 1.5 lb/MWh limit on NO_x emissions. CATF seeks a 50 percent reduction in mercury emissions from power plants, and a limit on CO₂ emissions 7 percent below 1990 emission levels. To the best of DES’s knowledge, CATF wants these reductions to occur quickly (e.g., 2003-2005) and believes that little or no trading should be permitted.

Clean Energy Group (CEG) – This organization of progressive Northeastern power companies has suggested two phases of regulation. In the first phase, SO₂ emissions would be reduced 50 percent from federal Phase II Acid Rain requirements by 2008. Seasonal (summer) NO_x emissions would be reduced by 2004 to levels consistent with EPA’s “22-State NO_x Transport SIP Call” (i.e., about 0.15 lb/mmBtu plus allowance for emissions growth). Mercury emissions would drop 50 percent from current levels by 2008, and CO₂ emissions would return to 1990 levels by 2008. In CEG’s suggested second phase, SO₂ emissions would remain unchanged, but NO_x emissions would be regulated starting in 2008 on an annual – rather than seasonal – basis, which would cut annual NO_x emissions by approximately 50 percent from first phase levels. CEG would target a 70-90 percent reduction in mercury emissions from current levels (i.e., 20-40 percent more than the first phase) by 2012, and would further reduce CO₂ emissions in 2012 consistent with future international climate commitments. CEG has also demonstrated a willingness to consider other, possibly more stringent, emission limits, especially in the context of a regionally or nationally consistent emission reduction program.

Among all the New England states, New Hampshire’s power plant emissions are relatively sizable, ranking second (after Massachusetts) for SO₂ and NO_x, and third (after Connecticut and Massachusetts) for mercury and CO₂. In the interests of regional environmental leadership and regional regulatory consistency, it is important for New Hampshire to join in these efforts to reduce power plant pollution. Also, since regional consistency among states is likely to produce even greater environmental benefit at less cost and confusion for sources, DES supports the development of an appropriate, regional, integrated, multi-pollutant emission reduction approach for power plants that provides maximum consistency from state to state. Initial meetings between state air directors, energy officials, public utility commissioners, and electric generating companies have been held to explore this possibility. As yet, however, no concrete unifying proposal has emerged. The NHCPS may serve as a model for a regional, and perhaps national, multi-pollutant approach to substantially reducing power plant emissions.

10.2. Emission Reduction Initiatives for Other Stationary Sources in New Hampshire

Although the NHCPS is specifically targeted toward power plants, DES’s pollution reduction efforts regarding SO₂, NO_x, mercury, and CO₂ emissions are not limited to these sources. *All* substantial NO_x emission sources in the State – factories, colleges, hospitals, etc. – are subject to NO_x RACT requirements. Moreover, through legislation passed in 1999, New Hampshire became the first state to regulate excessive NO_x emissions from diesel and other

internal combustion engines used to generate electricity on a full-time (rather than emergency-only) basis.⁹³

DES is also leading the effort to draft an “OTC Model Rule for Additional NO_x Control Measures” to provide a framework for additional NO_x reductions from non-power plant sources throughout the 12-state OTC region. This model rule will control NO_x emissions from a broad range of stationary sources not covered by the OTC NO_x Budget Program or EPA’s NO_x SIP Call, including industrial boilers, stationary combustion turbines, stationary reciprocating engines, emergency generators, and cement kilns. The purpose of this model rule is to help reduce NO_x emissions sufficiently to allow states to reach and maintain compliance with the 1-hour NAAQS for ground level ozone, and to make corresponding progress toward attainment of the 8-hour ozone NAAQS as well.

Outside of power plants, few stationary sources are significant SO₂ emitters on an individual basis. Because there are many of these sources, however, their collective emissions account for approximately 10 percent of the State’s total SO₂ emissions. In order to ensure that this sum remains small, DES imposes strict limits, in the course of its permitting processes, on the sulfur content of the fuel oil blends burned by these sources.

The provisions of the *New Hampshire Mercury Reduction Strategy* similarly span all source categories. Initial reductions have been sought from other large emitters – such as municipal waste combustors. In fact, New Hampshire’s largest municipal waste combustor recently installed carbon injection technology that reduced its mercury emissions by 96 percent. A recently installed acid gas scrubber should push this reduction to 98 percent. Similar reductions are anticipated by December 2005 at New Hampshire’s second-largest municipal waste combustor as a result of recent state legislation⁹⁴ and new federal regulations.⁹⁵ A bill introduced in the 2001 Legislative Session proposes to achieve these reductions sooner by helping the Claremont facility with the additional operating costs.

New Hampshire was also the first state in the nation to ban mercury thermometers, mercury in school laboratories (in kindergarten through the 12th grade), and mercury in novelty products. In addition, model legislation regarding labeling for mercury-containing products is expected this session. Reductions from smaller sources have generally been sought through “best management practices (BMPs)” such as source reduction and pollution prevention, although the State has also banned some mercury-containing products (e.g., flashlight batteries with added mercury).

In order to encourage early CO₂ reductions, New Hampshire initiated the nation’s first voluntary Greenhouse Gas Emission Reduction Registry as noted in Chapter 7. The State is also encouraging a number of energy efficiency initiatives, including “Solar on Schools” and other programs offered by the Governor’s Office of Energy and Community Services (ECS). The New Hampshire Public Utilities Commission also took a positive step in this direction

⁹³ New Hampshire RSA 125-J:13. See <http://www.gencourt.state.nh.us/legislation/1999/HB0649.html>

⁹⁴ New Hampshire RSA 125-M. See <http://www.gencourt.state.nh.us/legislation/1999/HB0625.html>

⁹⁵ See <http://www.epa.gov/ttn/uatw/129/mwc/rimwc2.html> and http://www.epa.gov/ttn/uatw/129/mwc/smwc_fs.html

recently, approving greater funding for energy efficiency programs in the State.⁹⁶ As with all energy efficiency efforts, by displacing electrical load, these programs reduce emissions of multiple pollutants (and purchase costs) that would have been associated with generating the electricity saved.

DES regularly reviews the inventory of pollutants emitted by all source categories. In the future, for example, it may be necessary to evaluate emissions from wood-fired boilers. Such boilers are generally cleaner than their fossil fuel-fired counterparts, but they still emit approximately twice as much SO₂ as new combined cycle natural gas-burning plants. Their NO_x emissions are nearly as high as the fossil fuel-burning plants, and 30-40 times higher than the new gas-fired plants. Wood-burning is comparatively benign in terms of CO₂ emissions – because wood is a renewable resource rather than a fossil fuel – but there is some evidence that CO₂ emissions from the wood plants may be one-third higher than those of fossil fuel-fired plants on a generation output (i.e., pounds per MWh) basis, probably due to relative generation efficiencies.

10.3. Emission Reduction Initiatives for Mobile Sources

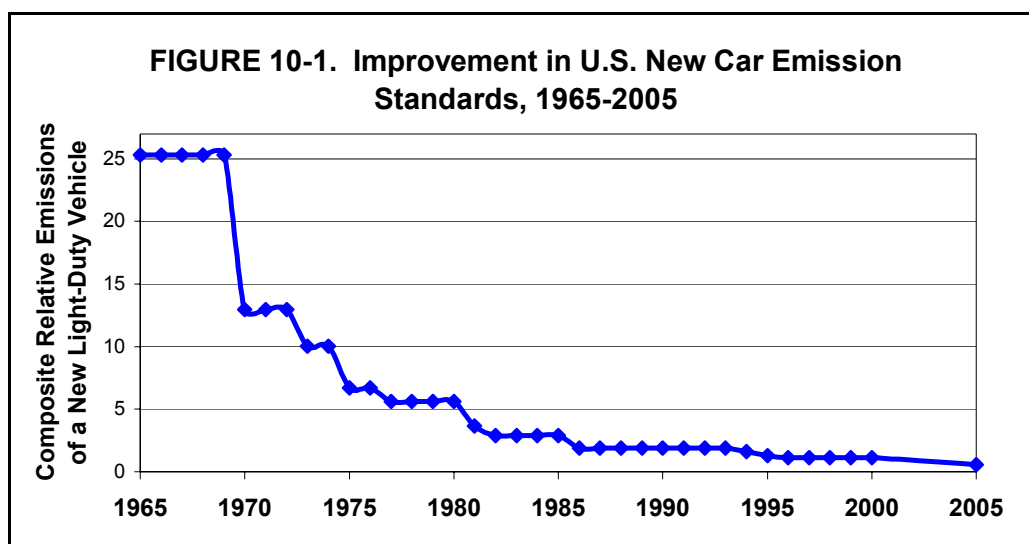
Securing aggressive emission reductions from motor vehicles can be a daunting task, because all states except California are pre-empted by the federal Clean Air Act from establishing their own emission standards for vehicles and fuels. This constraint has not deterred New Hampshire and other like-minded states, however, from working – usually but not always with EPA – toward this goal. That these efforts have been successful is evident in the fact that today's new cars emit 94 percent less NO_x than 1970 models did. Such reductions have been possible despite the fact that – unlike power plants – new automobiles must operate efficiently and cleanly under a variety of owners; when operated in a variety of ways; over a variety of climate, weather and operating conditions; in a number of different locations; using a wide variety of fuels; and operated with varying degrees of training and supervision.

Given the constraint of federal preemption, New Hampshire has concentrated its energies on pushing EPA to adopt new, more stringent standards for motor vehicle emissions and fuel quality. Through letters, press events, and other efforts, for example, Governor Shaheen and DES lobbied EPA and Congress intensely – against the wishes of the powerful national automobile and oil industries – for new standards that would reduce NO_x emissions from new cars and light trucks by 77-95 percent from today's models, and sulfur content in gasoline by an average of 91 percent by 2004. To New Hampshire's satisfaction, these regulations (known as the "Tier 2/Low Sulfur Gasoline Rule") were adopted in December 1999.

These efforts were on top of New Hampshire's 1998 decision to join the National Low Emission Vehicle (NLEV) program. NLEV is an agreement between many states and most automobile manufacturers to ensure that cleaner light-duty vehicles will be supplied to New Hampshire and other states between 1999 and 2006 than would otherwise be the case. Figure 10-1 illustrates the continuing overall improvement in emissions from a new car from 1965

⁹⁶ New Hampshire Public Utilities Commission, Order Nos. 23,574, *Energy Efficiency Programs* and 23,575, *Allocation of System Benefits Charge*, November 1, 2000. See <http://www.puc.state.nh.us/>

through 2005, and implicitly, the technological progress that has made this achievement possible.⁹⁷



Source: NESCAUM

Although light-duty vehicles (e.g., cars, SUVs, and pickup trucks) are far more numerous, heavy-duty vehicles (e.g., over the road trucks, buses, etc.) are far greater polluters. As a result, DES mounted similarly intense efforts to ensure that EPA adopted similarly stringent standards for heavy-duty engines and vehicles, as well as the tight limits on sulfur in diesel fuel that will make these standards achievable. By 2007, this regulation – known as the “Heavy-Duty Diesel Rule” – is expected to reduce particulate matter emissions by 90-95 percent compared to current levels, and NO_x emissions by 90 percent from 2004 levels (i.e., approximately 97 percent from current levels). In order to make these reductions possible, sulfur in diesel fuel will need to be reduced from about 500 parts per million (ppm) to just 15 ppm – a drop of 97 percent. After much effort by numerous states, including direct intercessions by DES, EPA finalized the Heavy-Duty Diesel Rule on December 21, 2000.

Notably, these federal emission reduction requirements are substantially greater than those the NHCPS recommends for power plants, indicating that these pollution sources are doing their fair share to clean up. In the future, fuel for “off-road” diesel emission sources (such as construction, agricultural, and forestry equipment) should also utilize fuel with much lower sulfur content. New Hampshire will continue to pressure EPA to regulate the quality of off-road diesel fuel. Finally, New Hampshire is among nearly a dozen states proposing to fill a federal loophole – referred to as the “not to exceed (NTE)” provision – that would enable heavy-duty diesel vehicles to bypass emission control requirements during the 2005-2006 period.

Once in use, automobile emission control systems can malfunction, so New Hampshire’s Enhanced Safety Inspection Program, instituted in January 1999, includes specific checks on

⁹⁷ Northeast States for Coordinated Air Use Management, *Environmental Regulation and Technology Innovation: Controlling Mercury Emissions from Coal-Fired Boilers*, September 2000. See <http://www.nescaum.org/pdf/hg-release.pdf>

these systems. In addition, in early 2000, DES and the New Hampshire Department of Safety (DOS) launched a pro-active training course to educate mechanics about soon-to-be-implemented additional inspection requirements for “on-board” diagnostic testing (OBD-II). OBD-II represents the future of vehicle emission control system maintenance, because it utilizes the vehicle’s own on-board computer to record and help diagnose emission system problems (along with many other mechanical malfunctions). With the assistance of the New Hampshire Association of Broadcasters, DES also aired public service radio announcements during the summer of 2000 to help educate the public about the upcoming OBD-II testing requirements.

Consistent with New Hampshire’s principle of setting an appropriate environmental example for others to follow, DES acquired the State’s first four-door “hybrid electric” vehicle in August 2000. This car – a Toyota Prius – gets over 50 miles per gallon using a small, optimized gasoline engine to charge and power an electric drive train. DES and the New Hampshire Department of Transportation (DOT) have also acquired a considerable fleet of cars that run on clean-burning natural gas. In addition, DES is working with the DOT regarding the widening of Interstate Route 93, and with the Manchester Airport concerning its major expansion, to ensure that emissions induced by these changes are mitigated to the greatest extent possible.

Finally, as clean as Tier 2 vehicles promise to be, DES and several other Northeast states are considering the merits of adopting motor vehicle standards consistent with those of California’s Low Emission Vehicle (LEV II) program. Collectively, the important mobile source initiatives noted above will ensure substantial reductions in SO₂, NO_x, particulate matter, VOC, carbon monoxide, and carbon dioxide emissions from motor vehicles for years to come.

11. THE NEW HAMPSHIRE CLEAN POWER STRATEGY (NHCPS)

11.1. Overview

Historically, emission control requirements have been mandated in an individual, pollutant-by-pollutant fashion by federal or state agencies in order to address the health and environmental threats posed by each pollutant. Fossil fuel-burning power plants, however, simultaneously emit several pollutants that cause or contribute to adverse health and environmental impacts. In such circumstances, sequentially implemented, pollutant-by-pollutant approaches are less than optimal. At best, they are likely to increase overall costs; at worst, one pollutant's emission controls may render another's ineffective. Certain NO_x emission controls, for example, can increase PM emissions. In addition, it is clearly desirable to avoid incurring emission control costs for one pollutant if the need to reduce emissions of a second pollutant can reasonably be expected to result in a shutdown of the facility. DES has been careful to factor this reasoning into its approach to reducing emissions at medical waste incinerators, for example, as several are expected to close in the next few years.

A superior strategy would utilize an integrated approach to simultaneously reduce emissions of four key pollutants: SO₂, NO_x, mercury, and CO₂. Ideally, only the desired results should be specified (e.g., emissions caps for all pollutants), leaving the facility operators free to determine how best to achieve these performance-based outcomes. An integrated approach, implemented using market-based measures and emission caps, would allow facility operators to make emission control decisions – and investments – on the basis of a comprehensive assessment, rather than in a piecemeal, pollutant-by-pollutant fashion. This capability is vital to market participants trying to navigate the as-yet-uncharted waters of New Hampshire's newly restructured, competitive electric industry. The New Hampshire Clean Power Strategy (NHCPS) reflects such a comprehensive, multi-pollutant approach to regulating air pollutant emissions from power plants.

The promise of utility restructuring – lower electricity prices with less environmental pollution – can best be realized if:

- All generators are subject to the same market rules;
- There are no advantages to incumbent generators;
- No undue barriers to entry exist in the generation market; and
- Consumers are provided with sufficient information to choose suppliers wisely.

As New Hampshire stands on the verge of divesting PSNH's generating assets to separate, privately-held enterprises, a significant competitive inequity exists between old and new power plants. As noted in Chapter 1, existing coal- and oil-burning plants are subject to much less stringent emission standards than those applicable to new entrants in the generation marketplace, effectively creating a "pollution subsidy" favoring the older, existing facilities. If this issue is not addressed up front (i.e., prior to divestiture of the existing facilities), and additional pollution controls are not required of the new owners once these facilities have been divested, this "environmental subsidy" will be perpetuated, and appropriate environmental costs will not factored into the price of power from these plants. As a

practical matter, this would shift the burden of the avoidable pollution from the power plants to the people, ecosystems, and natural assets existing downwind of them. Rather than incurring financial costs to remove the pollution, these costs would be paid in the currency of human health, natural damages, and economic shortsightedness via higher health care costs to society (increasing the burden on business, individuals, and government), greater government expenses to restore beaches fix erosion and other problems associated with flooding and more frequent and intense storm events, less revenue to federal, state, and local governments from tourism, more private property damage, lower agricultural and forest productivity, associated loss of jobs, etc.

Since higher pollutant emissions lead to unacceptable public health effects, environmental impacts, economic effects, and even political conflicts (e.g., interstate arguments over transported air pollution), the public's interest in greater competitive parity among electric generators coincides with the public's interest in better health, an improved natural environment, a more robust economy, enhanced quality of life, and setting an example for upwind jurisdictions. Both interests require that large electric generating facilities in New Hampshire – new and old – receive more equitable environmental treatment. The recommendations in the NHCPS adhere to this approach and are intended to move toward this goal.

11.2. Applicability

The NHCPS is intended to apply to all existing fossil fuel-burning power plants with a nameplate capacity of 25 MW or greater, which is the same applicability threshold used by EPA's NO_x SIP Call. Under this criterion, Merrimack Station Units 1 and 2 in Bow, Schiller Station Units 4, 5, and 6 in Portsmouth, and Newington Station in Newington would be subject to the NHCPS's provisions. The NHCPS does not apply to White Lake Station in Tamworth and Lost Nation Station in Northumberland, because the capacity of these facilities is less than 25 MW. Emissions from the combustion turbines at these infrequently-operated peaking facilities are relatively minor in any event, averaging in the case of NO_x, for example, a combined total of less than 50 tons per year.

The NHCPS also does not apply to the two new combined cycle natural gas power plants under construction in New Hampshire (i.e., Newington Energy in Newington and AES Granite Ridge in Londonderry). As new facilities, these plants are already subject to the more stringent federal and state environmental regulations cited earlier, including requirements to install state-of-the-art technology consistent with the "Lowest Achievable Emission Rate (LAER)" for NO_x emissions, and "Best Available Control Technology (BACT)" for all other criteria pollutants. In addition, the natural gas used by these facilities is inherently a much cleaner fuel. Table 11-1 illuminates the differences between emissions from the two new plants and those from the existing power plants to which the NHCPS will apply.

**TABLE 11-1. Emissions from New and Existing Fossil Fuel-Burning Power Plants
(1999 data used for SO₂, NO_x, and CO₂; 1997 data used for Mercury (Hg))**

| Plant - Location | Start Up Date | Capa- city (MW) | Fuel Used | SO ₂ , Tons/ Year | SO ₂ rate, lbs/ MWh | NO _x , Tons/ year | NO _x rate, lbs/ MWh | Hg, lbs/ Year* | CO ₂ , Million Tons/ year | CO ₂ rate, lbs/ MWh |
|------------------------------------|---------------------|-----------------------|--------------|------------------------------------|---|------------------------------------|---|----------------------|---|---|
| Merrimack - Bow | 1960 | 434 | Coal | 34,799 | 25.7 | 7,853 | 5.8 | 260 | 3.10 | 2,287 |
| Newington - Newington | 1974 | 406 | Oil & Gas | 15,515 | 21.5 | 2,416 | 3.35 | 81 | 1.56 | 2,161 |
| Schiller - Portsmouth | 1949 | 119 | Coal** | 5,380 | 15.2 | 1,807 | 5.1 | 68 | 0.92 | 2,603 |
| AES - Londonderry | 2002 | 720 | Gas** | 154 | 0.01 | 264 | 0.1 | Negl. | 3.04 | 760 |
| Newington Energy - Newington | 2002 | 525 | Gas** | 125 | 0.01 | 205 | 0.1 | Negl. | 2.22 | 760 |

* – AP-42 emission factors used to calculate these values are currently being revised by EPA.

** – Also capable of burning minor amounts of oil.

11.3. Covered Pollutants

The NHCPS establishes overall statewide emission limitations or reduction expectations for four key pollutants: SO₂, NO_x, mercury, and CO₂.

Because the NHCPS covers precursor pollutants that are the principal causes of PM_{2.5} and regional haze (i.e., SO₂ and NO_x), it does not require a distinct emission cap for PM_{2.5}, or new requirements to directly address regional haze, at this time. However, DES will continue to monitor PM_{2.5} concentrations. If the PM_{2.5} improvements expected from the NHCPS's SO₂ and NO_x reductions fail to materialize, DES may implement additional control measures to help New Hampshire avoid being designated by EPA as nonattainment of the federal NAAQS for PM_{2.5}.

Similarly, DES expects reductions in emissions of dioxin and other toxic compounds to parallel the specific pollutant reductions called for under the NHCPS. If the expected improvements do not occur indirectly in this fashion, DES may adopt additional control measures to accomplish these results.

11.4. Emissions Limits

The NHCPS will require a demonstration of compliance by each affected power plant such that the overall emissions caps denoted in Table 11-2 are met on an annual (12-month calendar) basis.

TABLE 11-2. Annual Emissions Caps Under the NHCPS

| Pollutant | Baseline Period | Baseline Tons* | Emissions Cap | Reduction from Baseline | Implementation Year |
|------------------|------------------------|-----------------------|----------------------|--------------------------------|----------------------------|
| SO ₂ | Current Allocation | 29,566 | 7,289 | 75% | 2006 |
| NO _x | 1999 | 12,077 | 3,644 | 70% | 2006 |
| Mercury | 1996/1997 | 328 lbs. | 82 lbs. | 75% | 2006 |
| CO ₂ | 1990 | 5,425,866 | 5,046,055 | 7% | 2006 |

* – Unless otherwise indicated

The NHCPS SO₂ cap of 7,289 tons represents a 75 percent reduction in annual SO₂ emissions, above and beyond the new Phase II requirements of Title IV of the federal Clean Air Act (i.e., the federal Acid Rain Program) that just took effect in 2000. This cap will reduce total New Hampshire SO₂ emissions from these sources by 89 percent since 1990 (see Figure 2-2 in Chapter 2).

The NHCPS NO_x cap of 3,644 tons represents a 70 percent reduction in annual NO_x emissions from 1999 levels, which is above and beyond the 68 percent annual (76 percent seasonal) NO_x reduction that New Hampshire has already achieved. This cap will reduce total New Hampshire NO_x emissions from these sources by 90 percent since 1990. Seasonal NO_x caps, independently established under DES's NO_x Budget Trading Program (Env-A 3200) will still apply (see Figure 4-4 in Chapter 4).

The NHCPS mercury cap of 82 pounds represents a 75 percent reduction in mercury emissions from New Hampshire's coal-burning power plants (i.e., Merrimack Station and Schiller Station) (see Figure 5-3 in Chapter 5).

The NHCPS CO₂ cap of 5,046,055 tons represents approximately a 7 percent reduction from 1990 levels (see Figure 7-5 in Chapter 7).

The proposed implementation year of 2006 was selected to allow the affected power plants (and their new post-PSNH-divestiture owner(s) a reasonable time period to plan and implement the control strategies necessary to achieve these caps, as well as an opportunity to take greater advantage of emerging technologies and to secure adequate capital to make the necessary changes.

11.5. Emissions Averaging, Banking, and Trading

In developing the NHCPS, DES consulted EPA's most recent 236-page guidance to determine which, if any, emissions averaging, banking, and trading programs should be included in this emission reduction strategy.⁹⁸ Several important considerations regarding averaging, banking, and trading are described below.

⁹⁸ U.S. Environmental Protection Agency, *Draft Economic Incentive Program Guidance*, September 1999. See <http://www.epa.gov/ttn/oarpg/t1/memoranda/eip9-2.pdf>

11.5.1. Averaging Between Units (e.g., Boilers or Turbines) at a Single Facility

Consistent with New Hampshire's practice since 1995, the NHGPS recommends that sources be able to demonstrate compliance with its SO₂, NO_x, and CO₂ emission caps by averaging across applicable operating units (e.g., boilers, turbines, etc.) at any single facility or site. Each individual unit will not be required to demonstrate that it meets the applicable cap, as long as the facility as a whole does so.

11.5.2. Averaging Between Multiple Facilities Owned by the Same Company

Also as practiced in New Hampshire since 1995, compliance with the NHGPS's NO_x, SO₂, and CO₂ emission caps can also be demonstrated by averaging among units at different facilities within New Hampshire owned by the same company. This will enable companies to achieve the NHGPS's recommended reductions in the most cost-effective way possible.

11.5.3. Banking of Early Reductions

To encourage early installation of emission controls, the NHGPS recommends that the State continue to allow facilities in New Hampshire to "bank" early reductions (and unused allowances from New Hampshire's NO_x Budget Trading Program and the federal Acid Rain Program, if any) and to carry them forward for future use under the NHGPS. Since 1995, the opportunity for banking has proved to be an effective motivator for companies to achieve emission reductions both prior to compliance dates and beyond regulatory requirements. In 1998, for example, PSNH was sufficiently encouraged by such provisions that the company voluntarily undertook additional early NO_x reductions equivalent to more than one-third of its allowable summer NO_x emissions. The incentive of banking has led to substantial early reductions throughout the OTC region.

11.5.4. Use of Allowances for Compliance (i.e., "Cap and Trade")

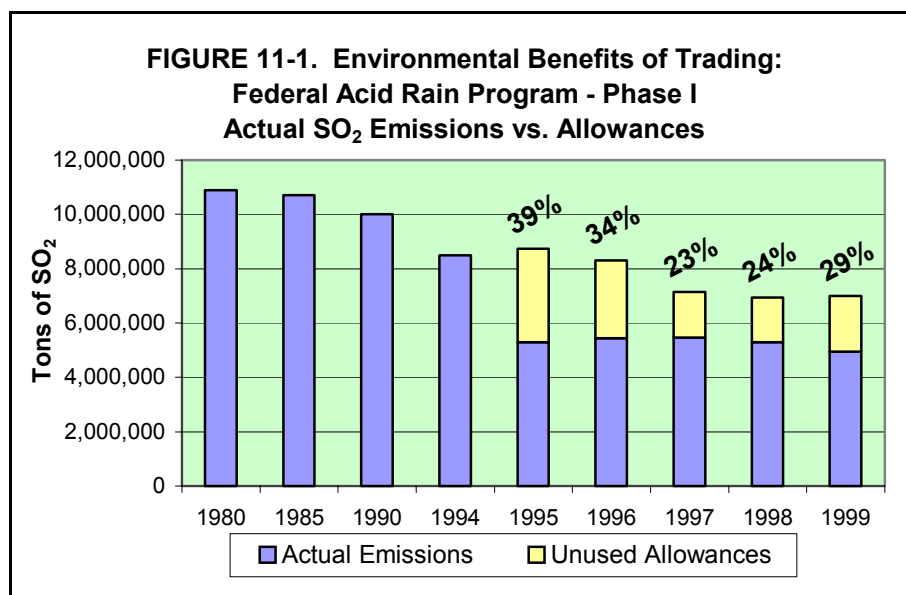
New Hampshire has successfully employed federal and regional "cap and trade" regulatory approaches for SO₂ and NO_x emissions respectively since 1995. In developing the NHGPS, DES considered the pros and cons of allowing facilities to use SO₂, NO_x, and CO₂ allowances, banked or purchased, in whole or in part, in order to meet the NHGPS's recommended emission caps. For some facilities, meeting these emission caps fully on a unit-by-unit basis may not be possible. Moreover, due to the tall stacks which normally exist at power plants, evidence indicates that local air quality impacts (e.g., within 50 kilometers or 30 miles) are likely to be less than those associated with transported air pollution.⁹⁹ As experience with cap and trade programs has shown, reductions secured from upwind sources can be expected to provide equal or greater benefit to New Hampshire's air quality – and correspondingly to public health and environmental quality in the State – and at substantially less cost.

Further, unit-specific caps are likely to put electric system reliability at greater risk, because they will drive all supply-side responses toward a single fuel source (i.e., natural gas). Equal

⁹⁹ U.S. Environmental Protection Agency, *Study of Hazardous Air Pollutant Emissions from Electric Utility Steam Generating Units, Final Report to Congress*, February 24, 1998.

or better environmental results can be achieved – at equal or less cost – through cap and trade approaches without incurring elevated reliability risk. According to an October 2000 report prepared by Energy Ventures Analysis for the New England Competitive Power Coalition (an organization of independent power producers, co-generators and power marketers), the region's best solution regarding reliability concerns lies in maintaining a diverse fuel mix.¹⁰⁰ In order to reduce the risk of impairing electric system reliability while retaining equal or greater environmental benefit to New Hampshire, the NHCPS recommends the use of market-based measures (e.g., allowances within a cap and trade framework) to comply with its emission caps.

Since its first major test with the federal Acid Rain Program, emission reduction trading has proven vastly more successful than Congress, EPA, state environmental regulators, or the environmental community had ever envisioned. Today's NO_x and SO₂ markets have delivered emissions reductions that are deeper, cheaper, and were achieved sooner than ever thought possible. Under Phase I of the federal Acid Rain Program, for instance, SO₂ emissions from 1995-1998 averaged 30 percent lower than allowed, and costs were 50-90 percent lower than originally estimated.¹⁰¹ Figure 11-1 illustrates this net benefit to the environment; even though the Clean Air Act allowed SO₂ emissions of 7–9 million tons from 1995-1999 (down from about 11 million tons allowed until 1995), the competitive emission reduction market engendered by trading kept actual Phase I SO₂ emissions uniformly below 5.5 million tons.



Source: US EPA

Economic savings from SO₂ trading under this program have been estimated by Resources for the Future (RFF) at \$784 million (approximately 43 percent) over the cost of achieving

¹⁰⁰ New England Competitive Power Coalition, *Consequences of a Natural Gas Dependency for New England's Electric Supply*, October 2000, (617) 248-9772.

¹⁰¹ U.S. General Accounting Office, *Acid Rain: Emissions Trends and Effects in the Eastern United States*, Letter Report, March 9, 2000, GAO/RCED-00-47. See http://www.access.gpo.gov/su_docs/aces/aces160.shtml

the same reductions through a unit-specific, command-and-control regulatory program.¹⁰² The Emissions Trading Education Initiative – a joint project of Environmental Defense (formerly the Environmental Defense Fund) and the Emissions Marketing Association (EMA) cites results that speak for themselves: All affected power plants have fully complied (which is not always the case with air pollution control programs); SO₂ emissions have been cut by 30 percent more than the original mandate (which means an extra 7.98 million tons of SO₂ were kept out of the air between 1995-1997); and the cost of the reductions – originally estimated to range between \$4 billion and \$8 billion per year – was only about \$1 billion per year.¹⁰³

By allowing regulated businesses the freedom and flexibility to seek out least-cost compliance strategies and technologies, America has obtained much more environmental benefit – at much less cost – than it would have achieved without this market-based approach. The federal SO₂ “cap and trade” system has created competition between power plants to develop the most cost-effective pollution reduction approaches (in order to make the plants themselves more competitive). This in turn has spurred competition among manufacturers of pollution control devices and systems, stimulating innovation, rewarding efficiency, and speeding the pace of technological development. Further, competitive markets for emissions reductions have encouraged sources to undertake additional reductions – beyond required compliance levels – on their own. This is because such reductions have economic value in a “cap and trade” system, whereas under a traditional, source-specific command-and-control approach, there is no economic reason for any source to reduce emissions beyond compliance levels.¹⁰⁴

Even the prospect of a competitive, “cap and trade” marketplace can spur these environmentally positive behaviors, because emission sources and technology developers undertake pro-active steps either to get a jump on their competitors or out of fear of being left behind. Markets have already developed for CO₂ reductions, for instance, even though no federal regulatory programs requiring such reductions have yet been adopted. Restricting or raising barriers to trading will reduce or eliminate this constructive dynamic, and diminish the demonstrated success of market-based approaches in achieving air pollution reductions.

Trading does not encourage facilities to increase emissions, it just allows them to forego on-site reductions by paying to have reductions made elsewhere. Although some decry trading on the grounds that any given source may thus be allowed to purchase its way out of making on-site emission reductions, the opposite is also true; additional reductions may occur where they were not required. Indeed, the latter situation has been more prevalent in New Hampshire’s experience. The State has been a direct beneficiary of the ability to trade NO_x allowances. Were it not for the incentives created by trading, Merrimack Station Unit 1 in Bow would not have installed an SCR system to further reduce its NO_x emissions, nor would Schiller Station on New Hampshire’s seacoast have installed an SNCR system to lower its NO_x emissions.

¹⁰² Carlson, C. et al. *Sulfur Dioxide Control by Electric Utilities: What are the Gains from Trade?*, April 2000. See http://www.rff.org/disc_papers/PDF_files/9844rev.pdf

¹⁰³ Emissions Trading Education Initiative (a joint project of Environmental Defense and the Emissions Marketing Association), *Real World Results*, 1999. See www.etei.org

¹⁰⁴ Ibid.

In any “cap and trade” system, it is important to remember that the overall pollution levels that are actually emitted to the environment are significantly reduced – and strictly limited – by the “cap.” Trading simply allows these reductions to occur at the facilities where emission controls are most cost-effective. This practice reduces overall cost, allowing equal or better environmental results to be achieved (as in the case of the federal Acid Rain Program) at the lowest possible cost. Attention to cost issues also enhances the political acceptability of environmental improvements, making possible “overall emission reductions that might not otherwise have been achieved without the opportunity to trade and bank.”¹⁰⁵ When trading systems fail to deliver anticipated benefits, the solution is to decrease the cap (i.e., the total pollution allowed to be emitted), not to eliminate trading.¹⁰⁶

Not surprisingly, the business community strongly supports market-based measures like “cap and trade” approaches, because such methods allow companies the flexibility and opportunity to find the most cost-effective approaches to compliance. Specifying the environmental results required, and leaving companies free to determine how to achieve them most effectively, benefits all concerned.

*As government regulatory schemes [regarding CO₂ emissions] start to take shape, companies should speak up. They should support programs that give them flexibility in deciding how to reduce emissions. A command-and-control approach ... could cost six times as much as market-based solutions, according to the White House Council of Economic Advisers. ... A tradable-permits system could reduce overall costs while giving businesses a continuing incentive to cut emissions.*¹⁰⁷

In this process, both the environment and the economy benefit, because these incentives allow new discoveries to be made and new technologies to be developed that can be marketed worldwide.

Even organizations without an industrial or environmental agenda, however, recognize the benefits to society that “cap and trade” approaches have provided. The National Academy of Public Administration (NAPA), for example, just completed an exhaustive report, funded by Congress, regarding how EPA and Congress should transform environmental governance by developing and deploying approaches to environmental protection that can deliver measurable environmental results more effectively and efficiently.¹⁰⁸ This report dedicates an entire chapter to “Using the Market,” and recommends that trading be continued and be extended from air pollution control programs to also address watershed threats:

¹⁰⁵ Burtraw, D. and Mansur, E., *Environmental Effects of SO₂ Trading and Banking*, Environmental Science and Technology, 33:20, August 31, 1999. See <http://pubs.acs.org/cgi-bin/jtextd?esthag/asap/html/es9902726.html>

¹⁰⁶ Bryner, Gary C., *New Tools for Improving Government Regulation: An Assessment of Emissions Trading and Other Market-Based Regulatory Tools*, Natural Resources Law Center, University of Colorado School of Law, October 1999.

¹⁰⁷ Packard and Reinhardt, *What Every Executive Needs to Know About Global Warming*, Harvard Business Review, July-August 2000, p. 132.

¹⁰⁸ National Academy of Public Administration, *Environment.com: Transforming Environmental Protection for the 21st Century*, November 2000. See <http://www.napawash.org/napa/environdotgov.pdf>

Among the most important public-sector innovations in environmental management in the United States today are those that apply market forces to environmental protection. They are significant for two reasons:

- *They are reducing the cost of improving air and water quality in many parts of the country; the less expensive it is to protect the environment, the better off society will be.*
- *They are demonstrating the effectiveness of the most plausible tools the nation might apply to outstanding environmental problems such as nonpoint runoff of nutrients into surface water and the emission of greenhouse gases.¹⁰⁹*

Among NAPA's key conclusions is the recommendation that Congress:

Authorize EPA and the states to implement allowance-trading systems to reduce pollution in air and water, explicitly liberating such systems from the constraints of traditional facility-based permitting, provided that trades would not result in unacceptable risks in local areas.¹¹⁰

NAPA's latter point – unacceptable risks in local areas – is principally directed at toxic air compounds and VOCs, not at the four pollutants included in this strategy:

VOC trading programs, because of the potential of some air toxics to create localized health risks, create particular technical and political challenges. Several states have shown considerable ingenuity in addressing those challenges. They have imposed higher trading ratios to discourage trades across long distances, and required on-site review of credit uses to protect against hot spots. The states, with EPA's encouragement and careful oversight, could continue to develop effective and responsible approaches for reducing VOC emissions through trading.¹¹¹

Even when consideration is limited to toxic air compounds, however, evidence strongly indicates that transported air pollution contributes more to human health risk than emissions from local power plants. In section 112(n)(1)(A) of the 1990 Clean Air Act, Congress directed EPA to perform a study of the public health impacts that could reasonably be anticipated due to hazardous air pollutant (HAP) emissions from steam electric generating units. EPA completed this study of utility toxics in February 1998 after analyzing 684 coal-, oil-, and natural gas-burning generating facilities in the U.S. (including 426 coal-burning plants).¹¹² Assessing local inhalation cancer risks from coal-burning power plants, EPA found that:

The cancer incidence in the U.S. due to inhalation exposure to HAPs (including radionuclides) from all 426 coal-fired plants based on the local analysis is estimated to be no greater than approximately 0.2 cancer case per year (cases/yr), or 1 case every 5 years. However, as described in later sections, the consideration of long-range dispersion of HAPs (beyond 50 km) results in increased estimates for cancer incidence.¹¹³ [emphasis original]

Assessing inhalation cancer risks from coal-burning power plants based on long-range transport, however, EPA concluded that the exposure from transported pollution was seven times greater than exposure from local impacts:

¹⁰⁹ Ibid, p. 65.

¹¹⁰ Ibid, p. 14.

¹¹¹ Ibid, p. 89.

¹¹² U.S. Environmental Protection Agency, *Study of Hazardous Air Pollutant Emissions from Electric Utility Steam Generating Units, Final Report to Congress*, February 24, 1998, p. ES-2.

¹¹³ Ibid, p. ES-8.

The long-range transport modeling indicates that the local HEM [Human Exposure Model] analysis alone does not account for a substantial percentage of the population exposures due to coal-fired utility emissions. A comparison of the HEM results to the RELMAP [Regional Lagrangian Model of Air Pollution] results indicates a significant portion of emissions disperse further than 50 km, as would be expected for these HAPs, which are mostly fine particulate substances emitted from elevated stacks.

*The RELMAP results for arsenic, cadmium, chromium, and nickel (which are mainly emitted as PM [particulate matter]) were used to estimate the potential long-range transport inhalation exposures for other carcinogenic HAPs. Using this methodology, the highest cancer incidence due to inhalation exposure to HAPs from coal-fired utilities considering both local and long-range transport is estimated to be up to 1.3 cases/yr, which is about 7 times greater than the incidence estimated in the local analysis alone.*¹¹⁴ [emphasis added]

Much of EPA's interest in mercury emissions from power plants – which led to its December 14, 2000 determination to begin regulating power plant emissions of mercury in 2004 – originated with this study. Even assessing mercury's health impacts via a multipathway exposure assessment, however, EPA concluded that:

*The modeling provided information on whether local and/or long-range transport of mercury is significant in a variety of scenarios. The models indicate that most of the mercury from utilities is transported further than 50 km from the source.*¹¹⁵ [emphasis added]

EPA's summary of its mercury assessment results for utilities reiterated this point:

*Modeling results suggest that most of the mercury emitted to the atmosphere is deposited more than 50 km away from the source, especially sources that have tall stacks.*¹¹⁶ [emphasis added]

EPA's report also cited a parallel report conducted by the Electric Power Research Institute (EPRI) regarding power plant HAP emissions entitled *Electric Utility Trace Substances Synthesis Report* (November 1994). EPRI had concluded that population inhalation risks were insignificant, and that multimedia risks, including mercury, were well below levels of concern. EPA took EPRI to task, however, precisely because EPRI had only included local impacts in its assessment:

*The EPRI's risk estimates are generally similar to, but in several cases lower than, those of EPA. Differences between the studies include: ... (3) EPA's evaluation of exposure [included areas] beyond 50 km to all [downwind] locations in the U.S. (EPRI did not attempt this analysis);... In addition, the EPRI mercury multimedia study considered only the local impacts from four plants (not worst case) and did not include potential impacts of total nationwide utility mercury emissions and contributions to total environmental loadings.*¹¹⁷ [emphasis added]

DES's experience with monitored data (rather than modeled data) regarding local impacts has led to conclusions consistent with EPA's utility toxics study. In late summer 1999, DES

¹¹⁴ Ibid, p. ES-12.

¹¹⁵ Ibid, p. ES-16.

¹¹⁶ Ibid, p. ES-18.

¹¹⁷ Ibid, p. ES-25.

studied total suspended particulate matter (TSP) and SO₂ concentrations recorded at a temporary monitor sited in Eliot, Maine. This monitoring site was specifically chosen for the purpose of measuring impacts from Schiller and Newton Stations, which are located directly upwind across the Piscataqua River. TSP and SO₂ were measured in 24-hour samples; SO₂ was also measured in 3-hour samples. The results of this monitoring indicated little cause for alarm regarding the local health impacts of these facilities relative to federal and state health-based standards:

The highest 24-hour TSP concentration measured in this study was 44 micrograms per cubic meter ($\mu\text{g}/\text{m}^3$), ... [just 17% of] the most recent federal and New Hampshire TSP standard of 260 $\mu\text{g}/\text{m}^3$... [and 29% of] Maine's TSP standard [of] 150 $\mu\text{g}/\text{m}^3$. The ten highest historical TSP concentrations measured at the same site between August 1983 and July 1984 (i.e., prior to Schiller Station's conversion to coal) all exceeded 44 $\mu\text{g}/\text{m}^3$, with a maximum concentration of 100 $\mu\text{g}/\text{m}^3$.¹¹⁸

The highest 3-hour average SO₂ level monitored during this study was 55 parts per billion (ppb), which is 11% of the federal and New Hampshire 3-hour SO₂ standard of 500 ppb and 12.5% of Maine's 3-hour SO₂ standard of 439 ppb. The highest 24-hour average SO₂ level monitored during this study was 13 ppb, which is 9% of the federal and New Hampshire 24-hour SO₂ standard of 500 ppb and 15% of Maine's 24-hour SO₂ standard of 439 ppb.¹¹⁹

Accompanying the research cited above, EPA modeled the geographic effects of trading under its 22-State NO_x SIP Call using the IPM utility dispatch model and found little if any benefit resulted from restricting trading. Of perhaps greater interest to New Hampshire, Burtraw and Mansur looked specifically at the environmental effects of SO₂ trading and banking, including geographical distribution of changes in emissions of SO₂, atmospheric concentrations of sulfates and deposition of sulfur, and public health benefits from reduced exposure to SO₂ and particulate matter.¹²⁰ Their conclusions include:

We assessed geographic and temporal changes at the state level that result from trading and banking and compared them with estimated cost savings. Our findings are not consistent with the fears of the [federal Acid Rain] program's critics. In the East and Northeast ... we found that health benefits increase and sulfur deposition decrease slightly as a result of trading. Nationally, trading results in health-related benefits in addition to significant cost savings.¹²¹ [emphasis added]

By holding aggregate emissions constant at the expected levels obtained under the program, pollutant concentrations decrease and health benefits actually increase in the East and Northeast due to trading. The expected result is health-related benefits nationally of \$125 million in 2005 as compared to a scenario with equal aggregate emissions that did not allow trading. Deposition of sulfur in the eastern regions also decreases by a slight amount as a result of trading, even in

¹¹⁸ New Hampshire Department of Environmental Services, *An Assessment of Airborne Particulate Matter Concentrations and Deposition in Eliot, Maine: An Ambient Air Monitoring Analysis Special Project*, August 2000, p. v.

¹¹⁹ Ibid, p. v.

¹²⁰ Burtraw, D. and Mansur, E., *Environmental Effects of SO₂ Trading and Banking*, Environmental Science and Technology, 33:20, August 31, 1999. See <http://pubs.acs.org/cgi-bin/jtextd?esthag/asap/html/es9902726.html>

¹²¹ Ibid, Abstract.

*New York State. Meanwhile cost savings from trading totals \$531 million, about 37% of compliance cost in 2005.*¹²² [emphasis added]

Burtraw and Mansur's trading scenario indicates that SO₂ emissions decline in all states upwind of New Hampshire as far as Ohio and West Virginia from 0-25 percent, that sulfur deposition declines everywhere east of Pennsylvania from 0-4 percent, and health benefits improve over the same region from 0-15 percent.¹²³ Regarding health benefits specifically, they conclude:

*Again, the fear that citizens in New England and the eastern seaboard might suffer health effects as a consequence of emission trading seems unlikely.*¹²⁴ [emphasis added]

The environmental certainty provided by cap and trade systems led many nationally-prominent environmental organizations, including Environmental Defense and the Natural Resources Defense Council, to support the market-based provisions of the 1990 amendments to the federal Clean Air Act. The exemplary performance of cap and trade programs since then, and the fact that market-based strategies promote new, less-polluting technologies,¹²⁵ has fortified this support.

In a September 11, 2000 press release, for example, Environmental Defense indicated that the federal Acid Rain Program "has helped the planet and the economy," and that this emission reduction strategy holds an "important lesson for further cuts and for addressing global warming."¹²⁶ Environmental Defense's recent analysis of SO₂ trading indicates that power plants have cut more than seven million tons of SO₂ pollution beyond their initial allotment from EPA (i.e., beyond compliance with their plant-specific emission reduction requirements).¹²⁷ These and other environmental organizations are now actively engineering international CO₂ trading programs based on this successful model.¹²⁸

For its part, EPA concurs with the environmental- and cost-effectiveness of allowance trading under a "cap and trade" system. EPA asserts that allowance trading is "the centerpiece" of its Acid Rain Program, and "allowances are the currency with which compliance with the SO₂ emissions requirements is achieved." Echoing the rationale DES used in developing the NHPCS's "cap and trade" approach, EPA emphasizes that:

¹²² Ibid, p. 2 of 9.

¹²³ Ibid, Figures 1,2,3.

¹²⁴ Ibid, p. 5 of 9.

¹²⁵ Natural Resources Defense Council, December 2000. See <http://www.nrdc.org/air/pollution/default.asp>

¹²⁶ Environmental Defense, *US Program to Cut Acid Rain has Helped the Planet and the Economy*, September 11, 2000. See http://www.environmentaldefense.org/pubs/NewsReleases/2000/Sep/c_acidrain.html

¹²⁷ Environmental Defense, *From Obstacle to Opportunity: How Acid Rain Emissions Trading is Delivering Cleaner Air*, September 2000. See <http://www.environmentaldefense.org/pubs/reports/SO2>

¹²⁸ For example, Petsonk, Annie, *The Kyoto Protocol and the WTO: Integrating Greenhouse Gas Emissions Allowance Trading into the Global Marketplace*, August 15, 2000. See <http://www.edf.org/programs/GRAP/WTOkyoto.pdf>

[T]he market-based allowance trading system capitalizes on the power of the marketplace to reduce SO₂ emissions cost-effectively and uses economic incentives to promote conservation and the development of innovative technology.¹²⁹

In addition, allowance trading creates a way for environmental goals to be met under difficult circumstances when they might otherwise be set aside. In recent years, for example, the New England Power Pool (NEPOOL) has periodically struggled to have sufficient generation capacity on line to meet peak electricity demand. In doing so, NEPOOL has occasionally sought from state environmental agencies temporary relief from stringent air emission requirements. Because allowance trading markets exist, the agencies have been able to approve such emergency relief – thus keeping the lights on for everyone – while still keeping the environment whole by requiring that an appropriate amount of offsetting allowances be secured and surrendered. Similarly, in situations where a power plant’s emission controls fail or malfunction, but system demand requires that the plant continue to run, the facility can still meet – rather than be excused from – its environmental obligations by using allowances that it had previously “banked” or by purchasing allowances (i.e., reductions made elsewhere) to “make-up” for its temporary excess emissions.

Finally, trading can even provide a way to help finance (e.g., through revolving loan programs) environmental and energy efficiency projects in disadvantaged communities. Through a pilot program in New York City called “Clean Air Communities,”¹³⁰ environmental justice and community-based advocates are collaborating with government, utility, and environmental representatives to fund projects that reduce energy, cost, and emissions. The latter can be quantified and sold on the allowance market, with the proceeds used to reinvest in additional projects.

11.5.5. Special Considerations Regarding Mercury

Because mercury is a persistent, bioaccumulative toxic compound (PBT), averaging, banking, and trading provisions may or may not be as appropriate for mercury as they are for SO₂, NO_x, and CO₂. Local deposition concerns may have some justification, although as indicated above, EPA modeling indicates that most mercury emissions from power plants are deposited more than 50 km away from the source. At the same time, trading is an appropriate vehicle to help reduce the greatest proportion of mercury deposited upon the State, i.e., that which is emitted from upwind sources and transported to New Hampshire by prevailing winds.

Following on its December 14, 2000 decision to eventually regulate mercury emissions from power plants (see Chapter 5), EPA is considering the issue of mercury trading for its own implementation purposes. In developing rules to implement the NHCPS, DES will factor EPA’s analysis (and any determination that EPA may reach) into its deliberations on this matter, in order to make the State’s program as consistent as possible with future federal mercury reduction regulations. Various “hybrid” trading approaches (e.g., combining local reductions and limited trading; using trading ratios; discounting and retiring allowances; etc.)

¹²⁹ U.S. Environmental Protection Agency, *Allowance Trading Fact Sheet*. See <http://www.epa.gov/acidrain/allsys.html>

¹³⁰ Clean Air Communities, *New Collaborative Commits \$5 Million for Clean Air Projects in New York City’s Impacted Communities*, September 21, 2000. See <http://www.cleanaircommunities.org/release.html>

that may lead to more cost-effective mercury reductions or help spur the development and use of new technologies to reduce mercury emissions will also be considered. Such approaches may be particularly appropriate in light of EPA's decision to regulate mercury from power plants using Section 112 of the federal Clean Air Act (i.e., the "MACT" provisions). The degree of mercury emissions reduction that EPA will seek remains unknown at this time, but it is unlikely to be as stringent as the NHCPS's mercury reduction target of 75 percent. As a result, "hybrid" approaches may hold particular promise in the case of mercury emissions.

11.6. Implementation Approach

DES has consistently operated on the principle that the implementation of major new environmental initiatives such as the NHCPS should receive explicit legislative consideration. Legislative authorization at the outset also reduces the chances that the resulting program will later be weakened or overturned. As a result, DES will work with appropriate House and Senate leaders to help develop legislation to implement the NHCPS.

Once adopted by the Legislature, signed by the Governor, and promulgated by DES, the emissions reduction requirements implementing the NHCPS would be enforced consistent with DES's existing authority under RSA 125-C, 125-D, 125-I, 125-J, and 125-M. In addition, sources will be required to file compliance plans with DES detailing technologies, operational modifications, market-based approaches, or other methodologies that they expect to use to meet the NHCPS's emission caps. Sources will also be required to monitor and report to DES their emissions and electrical generation.

As noted earlier, several other states in the Northeast are in the process of implementing requirements for additional emission reductions at electric power plants. These efforts are now at different stages in their statutory and/or regulatory authorization processes, and they reflect significantly differing approaches to the level and timing of emission reductions required and even the particular pollutants to be regulated. The NHCPS is the only state power plant strategy that includes concrete emission reduction requirements and timelines for all four pollutants (SO₂, NO_x, mercury, and CO₂). Because the public health and environmental impacts of these pollutants occur on a regional, national, and international basis, the most efficient and least costly way to achieve such reductions would be a regionally consistent approach implemented uniformly across the several states involved. As a result, the NHCPS recommends that DES re-evaluate particular elements of this strategy, if necessary, to comport with similarly aggressive regional or national integrated, multi-pollutant reduction strategies, should such strategies emerge.

12. ANTICIPATED BENEFITS

The benefits that implementation of the NHCPS promises can be categorized consistent with the key components of quality of life in New Hampshire: Public health benefits, environmental and ecosystem benefits, and economic benefits. Because discussion of the public health and environmental concerns associated with major environmental problems has been included in the preceding chapters, they are simply summarized in Section 12.1.

Economic considerations, however, are discussed extensively in Section 12.2. In addition, since environmental leadership is critical to the State of New Hampshire's ability to deliver appropriate improvements in public health, environmental protection, and economic well-being for its citizens, it is discussed in Section 12.3.

12.1. Public Health and Environmental Benefits

12.1.1. Nitrogen Oxides (NO_x)

NO_x is the principal cause of ground level ozone (or "smog"), and a lesser cause of the formation of fine particulate matter (or "soot"). Due to their profound public health and environmental impacts, reducing the precursor emissions that form these two pollutants is one of New Hampshire's top air pollution priorities. Together, ozone and PM_{2.5} are responsible for dozens of premature deaths annually in New Hampshire, hundreds of asthma attacks in children, and millions of dollars in healthcare expenditures. NO_x is also known to aggravate symptoms associated with asthma and bronchitis, and has been shown to lower resistance to respiratory infections and to increase respiratory illnesses in children. Ozone has also been shown to permanently diminish the lung function of children subjected to long-term elevated ozone concentrations. In addition, ozone reduces forest and agricultural productivity by interfering with photosynthesis.

The NO_x reductions proposed in the NHCPS will help alleviate this unnecessary suffering and cost by reducing regional ozone and maintaining lower ozone concentrations in the future. This, in turn, will help the State in meeting federal regulatory obligations associated with both the existing one-hour National Ambient Air Quality Standard (NAAQS) for ozone and the new federal eight-hour NAAQS for this pollutant. Under the Clean Air Act, economic sanctions can be imposed on areas that do not meet these air quality standards.

Reducing NO_x emissions as recommended by the NHCPS will also help reduce the formation and deposition of acid compounds, enhance visibility, diminish a greenhouse gas (N₂O) that plays a significant role in global climate instability, mitigate nitrification and eutrophication in New Hampshire's surface waters and coastal estuaries, and reduce the risk of harmful nitrate concentrations in drinking water. Please see Chapters 2, 3, 4, 6, and 8 for additional discussion regarding the health and environmental benefits of reduced NO_x emissions.

12.1.2. Sulfur Dioxide (SO₂)

SO₂ is the principal cause of fine airborne particulate matter (PM_{2.5}) in the Northeast, which results in dozens of premature deaths annually in New Hampshire – as noted above and in Chapter 3. Reducing these emissions as recommended by the NHCPS will help reduce this

mortality, as well as the incidence of asthma and other respiratory ailments afflicting New Hampshire citizens. Fewer doctor's visits and other medical procedures will reduce healthcare costs as well.

SO₂ reductions will also help ensure New Hampshire's attainment of the new federal NAAQS for PM_{2.5}, enabling the State to avoid the additional federal controls and/or sanctions that would be imposed as a result of a nonattainment designation. In addition, since SO₂ is the principal cause of acid deposition (e.g., acid rain) in the Northeast, and is the pollutant primarily responsible for the regional haze that diminishes the vistas so essential to New Hampshire's tourism economy, all aspects of New Hampshire citizens' quality of life (i.e., environmental, economic, and ecosystem) would be enhanced. New Hampshire's lakes, so critical to our recreational and tourist industry, would begin the long road back to recovery in terms of acid neutralizing capability. Please see Chapters 2, 3, and 8 for additional discussion regarding the health and environmental benefits of reduced SO₂ emissions.

12.1.3. Mercury (Hg)

Mercury has long been known to be a toxic, persistent, bioaccumulative pollutant with a wide range of human health and ecosystem impacts. The primary health effects from mercury are on the development of the brain and nervous system of children who eat contaminated fish, and in fetuses whose mothers eat contaminated fish. It is likely that subtle nervous system and developmental effects (such as attention deficit disorder) occur in children chronically exposed to relatively low concentrations of mercury. Exposure to high concentrations of mercury over a long period of time can also result in brain damage in adults. It is also thought that serious nervous system and reproductive disorders are occurring in some populations of fish-eating birds and mammals.¹³¹

Mercury is such a public health concern that New Hampshire's waters have been subject to fish consumption advisory warnings since 1994. In 1998 Governor Shaheen initiated a *New Hampshire Mercury Reduction Strategy* to combat emissions of this neurotoxic pollutant. Also, in cooperation with the other New England states and the eastern Canadian provinces, New Hampshire has committed to seeking a 50 percent reduction in statewide mercury emissions by 2003. As a result of these efforts, mercury emissions in New Hampshire are already down 37 percent. Ultimately, the State hopes to virtually eliminate anthropogenic (man-made) mercury emissions.

The mercury emission reductions recommended by the NHCPS will, over time, reduce the mercury cycling through New Hampshire's environment and entering the food chain. This should result in less neurological impairment and other health impacts in children (and correspondingly lower healthcare costs) and in fish-eating wildlife, as well as economic benefit from fishing if and when the State's fish consumption advisory warning can be lifted. Ultimately, mercury should become an environmental success story on a par with lead. Concentrations of lead in children's blood have dropped precipitously since that heavy metal was banned from gasoline. Please see Chapter 5 for additional discussion regarding the health and environmental benefits of reduced mercury emissions.

¹³¹ U.S. Environmental Protection Agency, Office of Water, *Air Pollution and Water Quality, Atmospheric Deposition Initiative*, 2000. See <http://www.epa.gov/OWOW/oceans/airdep/air3.html>

12.1.4. Carbon Dioxide (CO₂)

CO₂ is one of the principal greenhouse gases responsible for increasing concern in the international scientific community that the character of earth's climate is being altered by emissions from human activities. If unchecked, climate change could have multiple deleterious effects on the health of New Hampshire citizens and their quality of life.

Climate change may affect human respiratory health by changing ambient levels of pollens and air pollutants (particularly those formed in the atmosphere from precursor emissions, like ground-level ozone and a sizable fraction of PM_{2.5}). The impacts of climate change on ground-level ozone are both more certain and more likely to result in substantial health impacts. This is due to the importance of temperature in the formation of ozone, and the fact that large areas of the country – including some regions of New Hampshire – are already afflicted with ozone levels exceeding national, health-based standards. As extreme weather events like floods, hurricanes, and tornadoes become more frequent, the health risks of water-borne infections (from inadequate sanitation due particularly to combined sewer overflows) increase, as does the risk of injury or death from these events themselves. One of the greatest health concerns regarding climate change is that insect vector-borne infections (e.g., West Nile virus, malaria, Lyme disease, dengue fever, etc.) are likely to increase.¹³² Mortality from heat waves has been predicted to increase under most scenarios of climate change. Average summer mortality rates attributed to hot weather episodes are expected to double or triple in many U.S. metropolitan areas.¹³³

The complexity of the pathways by which climate affects health represents a major obstacle to predicting how, when, where, and to what extent global climate change may influence human well-being. Nevertheless, it is critical to keep in mind that uncertainty regarding adverse health outcomes is not the same as certainty of no adverse outcomes. Given the potential scope and irreversibility of ecosystem changes and consequent effects on human health and society, traditional public health values would urge prudent action to prevent such changes.¹³⁴

In addition, climate change will have substantial impacts upon New Hampshire's natural resources, including forest productivity, migration of tree species (e.g., maple, birch, and beech), habitat for animal species (e.g., lobster and trout), fall foliage, visibility, beach erosion and flood damage, water quality and quantity, and New Hampshire's change of seasons. Many of these environmental impacts have profound economic consequences as well as noted below. Please see Chapter 7 for additional discussion regarding the health and environmental benefits of reduced CO₂ emissions.

¹³² Balbus, John M., and Wilson, Mark L., *Human Health & Global Climate Change: A Review of Potential Impacts in the United States*, Pew Center on Global Climate Change, December 2000. See http://www.pewclimate.org/projects/human_health.pdf

¹³³ U.S. National Assessment Synthesis Team, U.S. Global Change Research Program, *Climate Change Impacts on the United States: The Potential Consequences of Climate Variability and Change*, 2000, p. 103. See <http://www.usgcrp.gov>

¹³⁴ Balbus, John M., and Wilson, Mark L., *Human Health & Global Climate Change: A Review of Potential Impacts in the United States*, Pew Center on Global Climate Change, December 2000. See http://www.pewclimate.org/projects/human_health.pdf

12.2. Economic Benefits

Although the implementation of the NHCPS could cause electric rates to increase marginally over what they otherwise might be, the NHCPS serves New Hampshire's economy better than alternative approaches – including no action to reduce air pollution from power plants. Implementation of the NHCPS may even result in lower electric rates by maximizing the value of PSNH's existing fossil fuel-burning power plants at auction, and reducing stranded costs that otherwise have to be recovered through rates. Further, the NHCPS will encourage greater energy efficiency and conservation, which will reduce energy costs for consumers. In addition, the NHCPS forces sources, rather than downwind citizens and ecosystems, to bear more of the burdens created by their pollution.

There is substantial doubt that the implicit threshold question – Will the NHCPS lead to an overall net cost increase to the citizens of New Hampshire? – can even be answered affirmatively. This is due to the fact that the multiple benefits the NHCPS provides contribute substantially to New Hampshire's economic well-being in many ways, not only to public health and environmental quality in the State. Unlike most narrowly-scoped economic and competitive assessments, one recently done by NetworkNH – *NH in the 21st Century: Competing in the New Economy* – grasps the importance of these interwoven dimensions to New Hampshire's economic competitiveness.¹³⁵

12.2.1. Recreation and Natural Resource Industries

The public health and environmental benefits discussed in prior chapters return substantial economic benefit through avoided health care costs; greater tourism resulting from healthy lakes and improved vistas; healthier wildlife ecosystems and the economic gains provided by wildlife viewers, hunters, and fishermen; and more productive forest and agricultural sectors. Economic benefit also derives from avoided costs to government (and ultimately taxpayers) to address flooding, droughts, more frequent severe weather events, damage to streets and infrastructure, etc. In addition, the economic benefit of retaining key natural resource elements of New Hampshire's quality of life and economic attractiveness – lobsters, white birches, fall foliage, maple syrup, etc. – cannot be overstated.

Recreation and tourism comprise the State's second largest industry. New Hampshire's White Mountain National Forest receives 7 million visitor days per year, an amount which exceeds that of Yellowstone and Yosemite National Parks combined. This is not surprising since about one-quarter of the U.S. population lives within one day's drive of the White Mountains. The 48 million tourists who visit New Hampshire each year spend over \$2.5 billion dollars in our state. Tourism directly supports one out of every 12 jobs in New Hampshire and contributes almost \$150 million annually to our State budget. Implementing the recommendations of the NHCPS will help to protect and preserve the natural resources that are the foundation of this industry.¹³⁶

¹³⁵ NetworkNH, *NH in the 21st Century, Competing in the New Economy*, December 1, 2000. See <http://www.network.com>

¹³⁶ New Hampshire Department of Resources and Economic Development, <<< cite >>>.

The New Hampshire Timberland Owners Association has estimated that the State's forest products industry directly supports 16,000 New Hampshire jobs, has a \$1.6 billion direct annual economic impact on the State, which extends to an indirect impact of \$3.9 billion or approximately 11 percent of New Hampshire's gross state product.¹³⁷ This health of this industry is entirely dependent on tree growth, which is materially impacted by ozone, acid rain, and climate change. Agriculture, equally dependent on plant growth, is similarly affected.

The American Sportfishing Association has assessed the economic contribution of recreational fishing to New Hampshire (based on 1996 data) at \$320 million per year in direct expenditures by anglers, with a total economic impact of over \$580 million and 7,710 jobs.¹³⁸ This industry depends on healthy surface water resources, which are adversely affected by acid rain and nitrogen and mercury deposition, and seriously altered by climate change. Wildlife viewing (e.g., birdwatchers, etc.) has a similar economic impact on the State, and also hinges directly on the suitability and stability of New Hampshire's natural habitat.

By reducing threats to the environmental underpinnings of these industries, implementation of the NHCPS's recommendations will help ensure that New Hampshire retains these substantial economic benefits to the State.

12.2.2. Maximizing the Auction Value of PSNH's Fossil Fuel-Burning Power Plants

One of the major economic benefits to New Hampshire of the NHCPS is that it will avoid the potential for "fear-based discounting" caused by uncertainty among prospective bidders during the divestiture of PSNH's generating assets. This is important because the lower the bids for PSNH's generating assets, the more that recovery of stranded costs will be shifted to ratepayers, and the less rapidly electric rates will decline.

DES's conversations with several energy industry consultants and potential acquirers of PSNH's generating assets indicate that buyers include consideration of future environmental regulatory requirements in their financial decision-making regarding acquisitions. Potential buyers of generating assets in the Northeast are particularly cognizant of this consideration due to recent emission reduction requirements on power plants imposed or proposed by the states of Connecticut, Massachusetts, and New York, as discussed in Chapter 10. This fact has already been evident in the calls DES has received from prospective bidders for PSNH's fossil fuel-burning power plants. They typically inquire about two things: the process for transferring permits, and what additional regulations may be coming in the future. Uncertainty regarding the degree of future reduction requirements, when they will take effect, how much they will cost, and whether or not there will be flexibility in achieving them is the greatest environmental concern for buyers, because uncertainty cannot be quantified and factored into bids. As a result, uncertainty creates increased risk, which leads to more heavily discounted bids (i.e., "fear-based discounting"). By eliminating environmental

¹³⁷ Kingsley, Eric, New Hampshire Timberland Owners Association, Personal Communication, May 3, 2000.

¹³⁸ American Sportfishing Association, *1996 Sport Fishing Participation and Economic Impact for New Hampshire*. See <http://www.asafishing.org/statistics/economic/index.cfm?state=New+Hampshire>

uncertainty, implementation of the NHCPS will help to maximize the auction value of PSNH's existing fossil fuel-burning power plants.

Although it is impossible to disaggregate a private acquirer's overall bid to discern what portion is solely attributable to environmental concerns, history indicates that bids made with the NHCPS in place are likely to be higher than bids made under conditions of uncertainty regarding future emission reduction requirements. If so, implementation of the NHCPS will actually serve to *reduce* electric rates (since a higher purchase price will require less recovery of stranded costs through rates). Early in the divestiture of regional generating assets, for example, the New England Electric System (NEES) was able to divest its power plants at a substantial premium. One of the key reasons was that because NEES engineered an environmental agreement with the Conservation Law Foundation and others regarding future power plant emission reductions, bidders had much greater certainty going into this acquisition.

Similarly, when the New England Power Company (NEPCO) divested its "15-Mile Falls" hydropower assets, the prior settlement of environmental issues – such as those associated with Federal Energy Regulatory Commission relicensing – allowed for an expedited term sheet to be prepared and distributed to bidders. This provided prospective buyers with much greater certainty, and NEPCO was pleased with the amount over book value that it received for these facilities.

Even if bidders do not "like" what they hear, they still value certainty because they can evaluate it economically and adjust bids accordingly. Since uncertainty is not subject to valuation, bids are heavily discounted for uncertainty. In addition, timing is often of the essence in auctions and acquisitions. The greater certainty that the NHCPS provides will facilitate expeditious timing by eliminating the need for bidders to negotiate and/or quantify alternative environmental settlements/regulations.

In addition, the fact that the NHCPS specifies New Hampshire's plans concerning power plant emission reductions in advance of the divestiture of these facilities will make these emission reductions an explicit component of the transaction for bidders to assess on a "going-in" basis. This may avoid subsequent surprises and protracted, costly regulatory battles or potential litigation after the fact.

12.2.3. Satisfying RSA 374-F:3,VIII (Environmental Improvement in Electric Restructuring)

The New Hampshire Legislature explicitly recognized the importance of including environmental protections in electric industry restructuring when it adopted RSA 374-F:3,VIII:

VIII. Environmental Improvement. Continued environmental protection and long term environmental sustainability should be encouraged. Increased competition in the electric industry should be implemented in a manner that supports and furthers the goals of environmental improvement. Over time, there should be more equitable treatment of old and new generation sources with regard to air pollution controls and costs. New Hampshire should encourage equitable and appropriate environmental regulation, based on comparable criteria,

for all electricity generators, in and out of state, to reduce air pollution transported across state lines and to promote full, free, and fair competition. As generation becomes deregulated, innovative market-driven approaches are preferred to regulatory controls to reduce adverse environmental impacts. Such market approaches may include valuing the costs of pollution and using pollution offset credits.

The NHCPS goes a long way toward delivering the promise of this law to New Hampshire citizens. It dramatically reduces emissions at previously “grandfathered” facilities, treating all sources more equitably. Further, allocating emissions allowances on the basis of generation output – rather than on the basis of historical emissions – rewards generation efficiency, and efficiency inherently fosters environmental improvement. Market-driven approaches are a cornerstone of the implementation of the NHCPS, and the NHCPS will set a clear example for upwind states in terms of the emission reductions that can be cost-effectively accomplished to reduce transported pollution. By helping to clarify and deliver upon the Legislature’s intent in RSA 374-F, the NHCPS should assist in the development of a competitive electric generation market in the New Hampshire.

12.2.4. “First-Mover” Advantage

Specifying emission reduction requirements for power plants substantially in advance of their effective dates may also enhance the competitive position of New Hampshire power plants. Under the NHCPS, New Hampshire generators will gain “first-mover” advantage as the EPA adopts additional regulations to meet new, health-based standards for ozone and fine particulate matter, and new emission control requirements to reduce mercury contamination and regional haze. The same dynamic applies if Congress adopts additional statutory requirements regarding SO₂, NO_x, mercury, and CO₂ emission reductions from power plants. Discussions, hearings, and the drafting of legislation have already commenced in Congress toward this end.

The State of New Hampshire and PSNH were both well served, for example, when PSNH installed the world’s first SCR system on a coal-fired cyclone boiler at Merrimack Station (MK2). The performance of this system far exceeded expectations in terms of NO_x reductions, equipment reliability, and cost-effectiveness. As a result of this “first-mover” experience, DES possessed a knowledge advantage regarding the feasibility and cost of NO_x controls that allowed the State to be a very effective advocate during the 37-state OTAG negotiations that eventually led to EPA’s NO_x Transport SIP Call.

PSNH utilized its first-mover status effectively as well. When the spot market for NO_x allowances under the OTC NO_x Budget Program exceeded \$6,000 per ton in early 1999, PSNH’s experience with SCR allowed it to quickly and confidently capture this revenue opportunity by installing a second SCR on the other boiler at Merrimack Station (MK1). The revenue thus secured more than paid for the SCR, and this control equipment will help keep Merrimack Station operating in compliance with NO_x emission limits in the years ahead.

Technological solutions implemented sequentially on a piecemeal, pollutant-by-pollutant basis are typically more expensive in the aggregate, often less effective environmentally, and sometimes even in conflict with each other. In contrast, undertaking emission reductions at

power plants via well-coordinated, multi-pollutant approaches will enhance the ability of affected power plants to compete in the generation marketplace of the future.

Aside from “first mover” advantage, companies that incorporate superior environmental performance into their business operations are more likely to enjoy superior overall performance as well. The Dow Jones Sustainability Group Index, for example, shows that by integrating economic, environmental, and social growth potentials into their business strategies, companies can generate added shareholder value. The companies included in this Index reflect approximately 25 percent better performance over the last five years than those in the broader Dow Jones Global Index.¹³⁹

12.2.5. Technology Opportunity and Job Creation

Due to the high technology nature of New Hampshire’s workforce, implementing an integrated, multi-pollutant strategy like the NHCPS is likely to enhance development of new technologies – and provide corresponding economic opportunity – in the State. Comprehensive, innovative regulatory approaches like the NHCPS encourage new technological responses and capabilities, which in turn create new jobs. This economic opportunity is not merely theoretical; at least one New Hampshire company is already nearing commercialization of a patented technology to reduce power plant emissions of three of these key pollutants simultaneously (i.e., SO₂, NO_x, and mercury).¹⁴⁰

Lower emissions of all four pollutants (i.e., SO₂, NO_x, and mercury, and CO₂) can also be achieved by using energy more efficiently or by using less carbon-intensive fuels (e.g., natural gas instead of coal or oil). Greater energy efficiency is typically achieved through the use of higher technology products and equipment. New Hampshire’s strong presence in the high technology economy suggests that efforts to seek emission reductions through energy efficiency – particularly if extended to a regional, national, or international scale – could lead to more high technology jobs in the State.

In an exhaustive climate review published as a special issue of the *Environmental Law Reporter*, this opportunity is cited repeatedly:

*In addition to reducing greenhouse gases, states are using these [policies and instruments] to save money, foster economic growth, reduce negative environmental externalities from electric generation, keep energy prices manageable for the poor, create new jobs, and foster technological innovation. In fact, it can be argued that their primary purpose and effect is to provide such benefits, because the climate change benefit to individual states ... is minor.*¹⁴¹

States using these [policies and instruments] also foster economic growth for companies that manufacture, construct, install, sell, and maintain renewable energy technologies and more energy-efficient or energy-conserving equipment. These [policies and instruments] can also provide additional economic benefits to farmers, foresters, and others who sequester carbon. As

¹³⁹ Dow Jones Sustainability Group Index. See <http://www.sustainability-index.com>

¹⁴⁰ Powerspan Corporation, *Powerspan Corp.'s ECO Technology Demonstrates Unmatched Reductions in Mercury and Fine Particulate Matter*, August 23, 2000. See http://www.powerspancorp.com/news/release_05.html

¹⁴¹ Dernbach, John, *Moving the Climate Change Debate From Models to Proposed Legislation: Lessons From State Experience*, *Environmental Law Reporter*, Special Issue, 2000, p. 10974. See <http://www.eli.org>

know-how, technological expertise, and product quality improve, the potential for international sales of products and services increases. Indeed, every one of these [policies and measures] provides, or can provide, such economic benefits.¹⁴²

National benefits include significant reductions in net greenhouse gas emissions, greater protection of national security, support for development of American technology, and greater overall employment. ... As an example, renewable energy portfolio standards would reduce CO₂ emissions at a low cost, diversify the nation's electricity portfolio, foster renewable energy across the country, and have little effect on electricity prices.¹⁴³

The Harvard Business Review, in an article about the impacts of climate policy on business operations, shares a similar view, "Such regulatory programs will change asset values. ... They will ... increase the value of goods and services as diverse as renewable-energy technology, process control equipment, and telecommunications services."¹⁴⁴ Such products, and the software that drives them, are characteristic of New Hampshire's high technology industry.

A crucial question regarding such policy changes as the NHGPS represents is, "Do investments [in cleaner energy] support more or fewer jobs for each dollar laid out than expenditures in more polluting and waste-generating industries?"¹⁴⁵ Renewable energy sources tend to create more employment than comparably sized fossil fuel sources. Energy efficiency building codes can also generate additional employment for manufacturers and installers of efficient equipment. Net metering and demand side management policies can also help create jobs for makers and installers of energy products.¹⁴⁶

Experience in Germany provides a telling example. In 1998, wind energy contributed only 1.2 percent of total German electric generation, yet it provided 15,000 jobs in manufacturing, installing, and operating wind machines. By comparison, nuclear power had 33 percent of generation and only 38,000 jobs, and coal-generated power contributed 26 percent of electric generation and provided 80,000 jobs.¹⁴⁷ Despite being much less capital-intensive and environmentally damaging, wind power provided over four times as many jobs as coal-fired generation, and nearly 11 times as many jobs as nuclear power, for the same amount of electricity generated.

Job creation in New Hampshire is not solely a function of technology development or energy efficiency. As pointed out in Chapter 8, for example, reductions in regional haze could significantly increase tourism (and associated jobs) at and near national and state parks and wilderness areas. Other industries, such as the restaurant, lodging, and retail trade sectors, would also expand to meet this demand.

¹⁴² Ibid, p. 10974.

¹⁴³ Ibid, p. 10979.

¹⁴⁴ Packard and Reinhardt, *What Every Executive Needs to Know About Global Warming*, Harvard Business Review, July-August 2000, p. 133.

¹⁴⁵ Renner, Michael, *Working for the Environment: A Growing Source of Jobs*, Worldwatch Paper 152, Worldwatch Institute, September 2000. See <http://www.worldwatch.org>

¹⁴⁶ Dernbach, John, *Moving the Climate Change Debate From Models to Proposed Legislation: Lessons From State Experience*, Environmental Law Reporter, Special Issue, 2000, p. 10974-5. See <http://www.eli.org>

¹⁴⁷ Renner, Michael, *Working for the Environment: A Growing Source of Jobs*, Worldwatch Paper 152, Worldwatch Institute, September 2000, p. 41. See <http://www.worldwatch.org>

Finally, the Worldwatch Institute offers this ominous perspective regarding job preservation:

*Most important, policy changes ... need to have a clear time horizon so that companies, communities, and individual employees know what they are up against. At the same time, however, the longer necessary changes are postponed, the greater the urgency later on to move speedily – and the more damaging the likely social and economic impacts. Delaying policies to mitigate climate change and to rein in other forms of environmental degradation will turn out to be a far greater job killer than embracing such policies in pro-active, strategic fashion.*¹⁴⁸
[emphasis added]

12.2.6. New Hampshire's Advantage

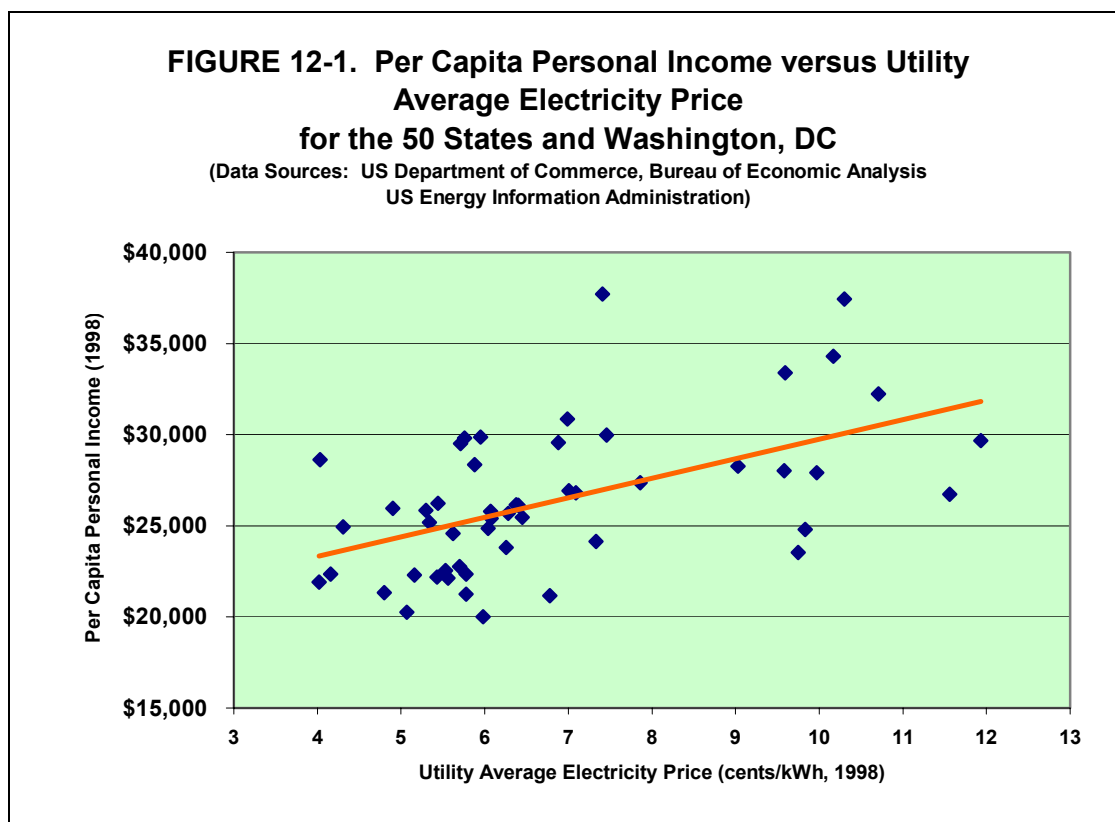
Fears regarding electric rate increases may be fanned by those who oppose environmental standards for older and higher polluting power plants. Any rate increase, this theory goes, may precipitate the demise of New Hampshire's economic success story. In reality, the data appear to show otherwise. For example, if high electric rates lead inevitably to economic decline, then New Hampshire – with the highest average electric rates in the country – should be in a grave recession. Of course, quite the opposite is true.

In fact, the postulated correlation between low electric rates and a healthy economy does not even hold up at the national level, at least if one considers state per capita income to be a valid measure of economic health. As Figure 12-1 shows, higher per capita income is correlated with higher – not lower – electric rates. Correlation is not causality, of course, so this does not suggest that higher electric rates cause higher per capita income. It does, however, disprove the idea that greater per capita income depends on lower electric rates.

Viewed more broadly than just electric rates and personal income, the question comes down to “Are healthy state economies and healthy state environments inextricably linked or mutually exclusive?” Is it possible for states to have both ?” The answer is a definitive “Yes.” As many studies have shown, states that enjoy greater economic well-being are *more* – rather than less – likely to have strong environmental protections, and vice versa.¹⁴⁹

¹⁴⁸ Renner, Michael, *Working for the Environment: A Growing Source of Jobs*, Worldwatch Paper 152, Worldwatch Institute, September 2000, p 31. See <http://www.worldwatch.org>

¹⁴⁹ See, for example, Institute for Southern Studies, <http://www.southernstudies.org>



Source: US Department of Commerce – Bureau of Economic Analysis,
and US Energy Information Administration

This suggests that there are more important factors driving New Hampshire's economy than simply electric rates, and that economic well-being and environmental quality in states may go hand-in-hand. Recent work by Brian Gottlob of PolEcon Research and Ross Gittell at the Whittemore School of Business at the University of New Hampshire, appears to confirm this outlook, indicating – as part of an effort for NetworkNH – that the cornerstone of New Hampshire's economic advantage is the State's quality of life.

The skilled labor shortage that the current economic boom has created is increasingly forcing companies to locate in the places where their employees want to live. New Hampshire offers its residents an excellent natural environment with a diversity of landscapes and ready access to lakes, beaches, mountains, cities, education, recreation, and technology. These attributes allow companies that locate in New Hampshire to attract the educated, innovative, productive – and mobile – workers that they need to remain globally competitive. Recent announcements of new facilities by Cisco Systems, Corning, and Lasertron – bringing thousands of new jobs to the State – are a case in point.

NetworkNH's watershed white paper – *NH in the 21st Century: Competing in the New Economy* – makes this point squarely:

There is a distinct culture in the New Economy. Business leaders and employees no longer base their decisions on where to locate and work solely on economics: they also place great value on their personal lives and their ability to live in a "high amenity" environment. Natural and

*recreational opportunities and culturally rich and vibrant communities attract New Economy entrepreneurs and employees. New Hampshire has benefited in the New Economy by presenting a high quality living environment. We must preserve, develop, and refine our quality of life advantage.*¹⁵⁰

The Worldwatch Institute concurs, and at the same time illustrates that other areas of the country have also figured out the “economic secret” of competing on the basis of quality of life:

*As businesses become less dependent on resource inputs, it matters less where they locate; with this [geographical] constraint lessened, people will be more easily drawn to the most livable and enjoyable areas. ... The Pacific Northwest is living proof that communities and regions will fare better if they keep their environment pristine.*¹⁵¹

If these conclusions are true, then steps that enhance quality of life in New Hampshire will also enhance the State’s future economic well-being. By addressing the public health and environmental problems described in Chapters 2 through 9, then, implementation of the NHCPS will improve the State’s natural environment, its quality of life, and ultimately, its economy.

Business interests may also be supportive of the NHCPS for another, albeit smaller, reason. Under the Clean Air Act, areas designated as “nonattainment” of NAAQS face onerous constraints on new economic development and transportation projects. Since the seacoast and south-central areas of New Hampshire are currently designated as “nonattainment” for ground-level ozone, the State’s business community is well aware of these constraints. For instance, new major sources locating in the state must acquire emission allowances that more than offset their emissions, making the air cleaner than they found it.

Perhaps as early as Summer 2001, EPA will begin the process of classifying areas as “attainment” or “nonattainment” under the new 8-hour NAAQS for ground-level ozone. In the 2002-2003 timeframe, EPA plans to make similar designations under the new NAAQS for PM_{2.5}. For areas designated “nonattainment,” EPA will then impose additional emission reduction requirements. By greatly reducing power plant emissions of NO_x and SO₂ – the key precursors of ground-level ozone and PM_{2.5} – the NHCPS will cost-effectively help avoid “nonattainment” designations in New Hampshire. Even if certain areas are so designated, the NHCPS’s provisions will serve as a substantial “down-payment” toward the additional emission reductions that EPA will require.

12.3. Environmental Leadership

The NHCPS is a decisive “next step” in New Hampshire’s tradition of environmental leadership. Much of New England’s air pollution is emitted upwind and blown eastward by prevailing winds. Complaining about this phenomenon is rarely effective, so New Hampshire has historically “set an example” for upwind jurisdictions by lowering its own

¹⁵⁰ NetworkNH, *NH in the 21st Century, Competing in the New Economy*, December 1, 2000, p. 16. See <http://www.network.com>

¹⁵¹ Renner, Michael, *Working for the Environment: A Growing Source of Jobs*, Worldwatch Paper 152, Worldwatch Institute, September 2000, p 38. See <http://www.worldwatch.org>

emissions. The subsequent success of these efforts demonstrates that similarly aggressive reductions are technologically and economically feasible for all jurisdictions, including those upwind of New Hampshire.

In the case of the NHCPS, New Hampshire joins with several other Northeast states (e.g., Connecticut, Massachusetts, and New York) endeavoring to secure additional emission reductions from power plants in an integrated, multi-pollutant fashion. The wisdom inherent in this approach is gaining ground in Washington, DC as well. New Hampshire Senator Bob Smith has initiated discussion within the U.S. Senate Committee on Environment and Public Works about the concept of an integrated, four-pollutant emission reduction program for power plants nationwide. Similar legislation is also being contemplated in the U.S. House of Representatives. Further, President Clinton urged federal and state policy makers in the direction of four-pollutant strategies as part of an environmental address given on November 11, 2000. In keeping with New Hampshire's proud air quality tradition, implementation of the NHCPS will demonstrate the feasibility and effectiveness of multi-pollutant reductions from all power plants in all states, and perhaps become a national model. This, in turn, will contribute to progress on the federal level, which is essential for diminishing the transported pollution that New Hampshire receives.

Some have suggested that being "at the front of the curve" in terms of environmental leadership – with the intention of showing the way for others to follow – is a flawed strategy that has not been successful in the past. When one reviews the record, however, it is apparent that New Hampshire's environmental leadership has not only been very successful, it has been essential. A look at several examples bears out this conclusion:

Acid Rain – Recognition of Acid Rain as an environmental and economic problem originated with scientists at the Hubbard Brook Experimental Forest in New Hampshire's White Mountains. (Operating since 1963, the Hubbard Brook Ecosystem Study is one of the longest running and most comprehensive ecosystem studies in the world.) Exhibiting environmental leadership, the State of New Hampshire adopted aggressive legislation to reduce SO₂ emissions from the State's power plants in 1985. Other states in the Northeast did likewise, collectively proving that such reductions were feasible. After a difficult and sustained regional conflict, the Clean Air Act Amendments of 1990 finally adopted similar SO₂ reduction requirements for power plants across the nation. Notably, SO₂ compliance costs now average 10-20 percent of what the electric utility industry originally estimated they would be. Unfortunately, despite the success of the federal Acid Rain Program that resulted, Northeastern surface waters and ecosystems are not recovering as readily as hoped, and further – even more aggressive – SO₂ cuts appear necessary. Recognizing this fact, New Hampshire and the other New England states and Eastern Canadian provinces have already committed to an additional 50 percent cut in SO₂ emissions by 2010. The NHCPS recommends going beyond this commitment, increasing the reduction to 75 percent and implementing it in 2006.

Nitrogen Oxides (NO_x) – In 1994, the installation of selective catalytic reduction (SCR) technology to control NO_x emissions on PSNH's Merrimack Station Unit 2 (MK2) was the world's first SCR installation on a coal-fired, cyclone-design boiler. While policy forums like the 37-State Ozone Transport Assessment Group (OTAG) were debating utility industry NO_x reduction cost estimates of \$2,000-5,000 per ton, PSNH and DES were able to demonstrate – at the very first point "on the learning curve" – that NO_x emissions could be reduced for just \$400-500 per ton. The OTAG process concluded in 1997, recommending NO_x reductions of up to 85 percent for power plants. EPA responded with a similarly aggressive regulation – the 22-State

NO_x Transport SIP Call. This rule was litigated by some industries and Midwest states, but EPA prevailed in 1999. New Hampshire's leadership in this process was recognized by many of its sister states as essential to its constructive outcome. Again, along with the New England Governors Conference and Eastern Canadian Premiers (NEGC/ECP), New Hampshire has already committed to an additional 20-30 percent cut in SO₂ emissions by 2007. The NHPCS recommends going beyond this commitment, increasing the reduction to 70 percent and implementing it in 2006.

Mercury – Discussions in 1997 between the jurisdictions of the NEGC/ECP led to the recognition that mercury emissions must be cut for the variety of reasons discussed in Chapter 5. In June 1998, the NEGC/ECP approved its *Mercury Action Plan*, which called for a collective regional mercury reduction goal of 50 percent by 2003. Soon after, in October 1998, Governor Shaheen announced the *New Hampshire Mercury Reduction Strategy*, with even more aggressive goals. To date, the State has already reduced mercury emissions statewide by 37 percent. DES has also participated aggressively in several NESCAUM and other analyses concerning developing technologies to control mercury from power plants. On the basis of these reports and its own information-gathering, EPA announced on December 14, 2000 that it would regulate mercury emissions from coal-fired power plants, targeting a final rule by the end of 2004. Without the leadership efforts of the NEGC/ECP and New Hampshire on mercury, it is not clear that EPA would have taken this step. Once implemented, EPA's regulation should materially reduce the mercury being deposited upon New Hampshire.

Air Toxics – New Hampshire policymakers were similarly responsive to the need for environmental leadership regarding toxic emissions to the air. New Hampshire's Legislature adopted a program to control hazardous air pollutants in 1987, again before similar protections were adopted at the federal level. As a result of this program — and dedicated efforts by New Hampshire businesses — the state has consistently been ranked at or among the top states nationally on EPA's Toxic Release Inventory (TRI) for reducing toxic air emissions. In 1996, New Hampshire's program was improved further with the addition of annual emission standards; a new, comprehensive list of regulated compounds; greater flexibility in adding and removing listed compounds; and an eventual elimination of grandfathered toxic emissions. Such state efforts helped spur federal action to address toxic emissions on a national basis, and a separate title regarding hazardous air pollutants was included in the 1990 Amendments to the Clean Air Act. Since then, EPA has dedicated much more attention to toxic compounds in the ambient air (including its Cumulative Exposure Project and its National Air Toxics Assessment) and to studying toxic emissions from power plants and mobile sources.

Voluntary Greenhouse Gas Emission Reduction Registries – As noted in Chapter 7, New Hampshire has also been a leading state on the issue of climate change. New Hampshire introduced the first voluntary Greenhouse Gas Emission Reduction Registry in 1999, and several New Hampshire companies have already indicated that they plan to register CO₂ reductions with the State. Following New Hampshire's lead, similar legislation passed in Wisconsin and California in 2000. Further momentum appears to be building: other states are now considering similar initiatives, discussions are underway to build greater uniformity among state registries, and interstate reciprocity agreements could lead to widespread de facto GHG trading in the United States.

Diesel Emission Reductions – As noted in Chapter 10, the State of New Hampshire has been an ardent supporter of stringent new standards for diesel engine emissions – in both on- and off-road applications. Due to federal pre-emption, the State is not permitted to adopt its own standards for diesel engine emissions and fuel sulfur content. Joining with the other NESCAUM states, however, New Hampshire did institute a diesel opacity inspection program, which subjects dirty

diesels to roadside enforcement checks. On December 21, 2000, EPA announced its adoption of new, aggressive Heavy-Duty Diesel emission reduction requirements. Without concerted pressure from states such as New Hampshire, as demonstrated by our willingness to conduct opacity checks and lobby pro-actively for diesel reductions, it is not clear that EPA would have delivered these new standards. Moreover, New Hampshire recently joined with several other Northeast states, Texas, and California to close a two-year loophole for the manufacture of dirtier diesels in 2004 and 2005. Since manufacturers are unlikely to produce two kinds of vehicles – one for these 15-20 states and one for the other states – for just a two-year window, cleaner diesels should be sold throughout the country as a result of this action.

Low-Emitting Vehicles (LEV) – Although LEVs have not been a significant issue in New Hampshire, they still serve as a solid example of the benefit of state leadership. Under the Clean Air Act, states can only require new car standards consistent with the federal standard or with California’s standard. Several Northeast states (including New York, Massachusetts, Maine, and Vermont) chose the more stringent California standard, even though they were litigated over this policy. This fact, coupled with pressure from other states like New Hampshire, ultimately led EPA to adopt much more stringent “Tier 2” standards for new cars, and limits on sulfur content in gasoline, in December 1999.

Dioxin – As the latest step in the tradition of New Hampshire environmental leadership, DES is in the final stages of preparing a strategy to reduce harmful concentrations of carcinogenic dioxin emissions (see Chapter 5). It is too early to know what broader regional or national health and environmental protections will ultimately result from this plan, but its existence testifies to DES’s belief that leadership on such environmental threats – as shown above – is both constructive and effective.

Many other states and prominent corporations recognize the importance of environmental leadership. As quoted in the *Harvard Business Review*, for instance, Chris Gibson-Smith, BP Amoco’s Executive Director for Policy and Technology, said:

*Do not underestimate the power of pre-emptive, aspirational target setting. The role of leadership is to invent actions that naturally have the consequence of transforming people’s thinking.*¹⁵² [emphasis added]

The NHPCS is consistent with this direction, comports with the State’s tradition of air quality leadership, and will help demonstrate the economic and technological feasibility of making the substantial emission reductions that New Hampshire ultimately needs from upwind emission sources. As the earlier discussion of economic benefits shows, New Hampshire’s quality of life and economic well-being will ultimately benefit, along with the health of its citizens and its natural environment.

¹⁵² Packard and Reinhardt, *What Every Executive Needs to Know About Global Warming*, Harvard Business Review, July-August 2000, p. 133.

13. ESTIMATED COSTS

In responding to potential environmental threats, DES assesses the nature of the concern (e.g., is it a threat to public health, environmental quality, or both); its magnitude (i.e., how significant and how pressing is it); what options exist for reducing or controlling the threat (e.g., through pollution control technologies; policy options like pollution prevention or, if necessary, limitations or bans; or economic and market-based instruments); and what the costs of those various options are estimated to be (i.e., how cost-effectively can the threat be diminished). This process is often compounded by various “feedback loops” and tensions inherent in it, such as the fact that commercialized technologies to address environmental threats rarely precede the regulations which provide their developers with a market,¹⁵³ so regulations often contribute to the development of new control technologies. In addition, environmental threats are rarely unique to New Hampshire. Often, solutions require the involvement of several different-minded states and federal environmental policy makers.

Nevertheless, DES always considers cost issues associated with new regulations, and routinely evaluates the feasibility and cost-effectiveness of various alternatives, as the discussion below demonstrates. Further, once authorizing statutes are adopted, DES’s longstanding policy of involving outside stakeholders in working groups or task forces charged with drafting reasonable, cost-effective administrative rules ensures that these concerns are taken into consideration even prior to the normal public hearing and comment process.

Please note that in the following discussion, DES has generally included what it believes to be high-end cost estimates. High-end estimates assume, for instance, that few multiple benefits will occur (i.e., wherein one control technology simultaneously reduces emissions of several pollutants), so that compliance for all or most of the four pollutants will have to be achieved separately. Although this analysis does consider some “co-benefit” effects (which result in the low-end cost estimates included herein), it does not include what could be the least cost and most likely route to maintaining the emission caps recommended by the NHCPS: incrementally less use of some or all of the affected facilities due to changes in the dispatch order of the generating facilities serving the New England power pool. “Dispatch order” is the ranking of generating facilities – typically by increasing cost – used to determine which will be the next power plant to be brought on line when more electricity is needed to meet hour-by-hour demand. As new generation is brought on line in the region, dispatch order rankings will change to favor those with the lowest fuel costs and highest generation efficiency. If the facilities affected by the caps recommended in the NHCPS are dispatched less – or ultimately shutdown – the NHCPS’s caps may be met with essentially zero incremental cost to electricity consumers.

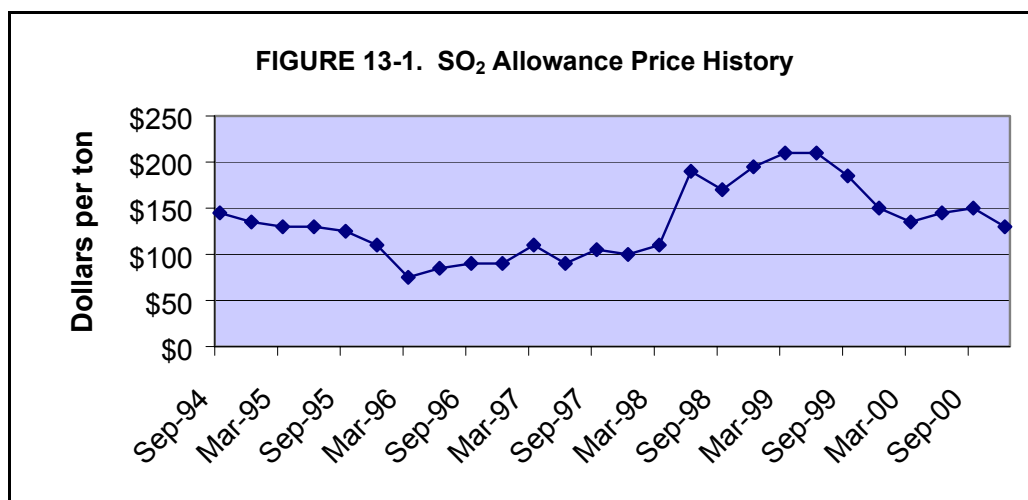
13.1. Estimated SO₂ and NO_x Control Costs

Active markets currently exist for SO₂ and NO_x emission reductions, so valuation of these pollutants is relatively straightforward. The cost to implement the NHCPS’s NO_x and SO₂

¹⁵³ Northeast States for Coordinated Air Use Management, *Environmental Regulation and Technology Innovation: Controlling Mercury from Coal-Fired Boilers*, September 2000.

caps can be estimated simply by assessing the number of allowances (in tons) that would be required to comply, and multiplying that figure by the market price for such allowances. Of course, if a source could achieve compliance more cost-effectively through the installation of on-site control technology or through other means, then compliance costs would be lower. Moreover, many sources that find themselves in this situation voluntarily install technology that goes beyond compliance, which enables them to further minimize costs (in today's cap-and-trade programs) by selling allowances. Whenever the marginal cost of reducing emissions beyond compliance levels is less than the market price for allowances, it makes economic sense to go the extra mile environmentally. Achieving compliance entirely through the purchase of allowances should thus represent a maximum cost scenario.

As Figure 13-1 shows, SO₂ allowance prices have generally ranged between \$100 and \$200 over the last six years, averaging less than \$150 per ton. Compliance with the NHCPS's recommendation for SO₂ (for all three affected power plants combined) would require approximately 18,832 additional allowances (beyond current regulatory requirements) per year. At \$150 per ton, SO₂ compliance achieved exclusively by purchasing allowances would cost approximately \$2,824,800 per year. This amounts to approximately 0.06¢ per kWh, or 30¢ per month for an average household using 500 kWh monthly. Appendix 1 illustrates SO₂ compliance costs based on recent allowance prices.



Source: Cantor Fitzgerald Environmental Brokerage Services¹⁵⁴

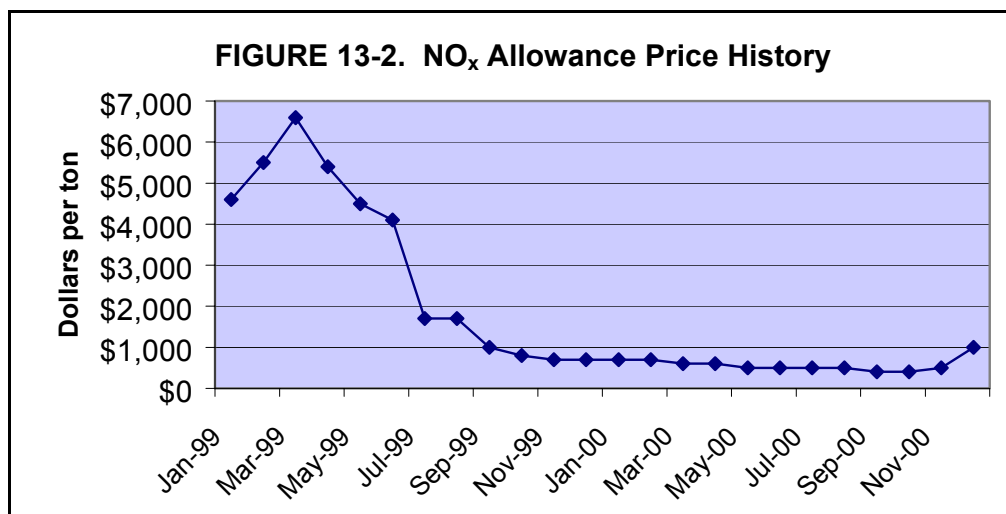
Figure 13-2 shows that NO_x allowance prices have been much more volatile than SO₂ allowance prices. NO_x allowance prices experienced a very high peak soon after the NO_x market began operation, but they have generally hovered around \$500 per ton for the last year. Recently they exceeded \$1,000 per ton, but analysts "could point to no fundamental market shift that could sustain [such] higher prices over the long term."¹⁵⁵

A number of factors have contributed to greater volatility in the NO_x market. First, the high early peaks (e.g., March 1999) are commonly attributed to a tight supply-and-demand

¹⁵⁴ Cantor Fitzgerald Environmental Brokerage Services, *SO₂ and NO_x Market Price Index*, December 27, 2000. See <http://www.cantor.com/ebs/>

¹⁵⁵ AirDaily, *NO_x Price Spike May Be Short Term*, January 12, 2001.

situation for compliance with the first year of the OTC NO_x Budget Trading Program. Second, at just under two years old, the NO_x allowance market is much less mature than the SO₂ market. Third, sources in the OTC states have been the principal players in the NO_x allowance market to date. As EPA implements its 22-State NO_x Transport SIP call, however, many more sources over many more states will be involved. As this market matures and more players participate in it, price volatility can be expected to decline.



Source: Cantor Fitzgerald Environmental Brokerage Services¹⁵⁶

Compared to current emissions, approximately 8,433 additional NO_x allowances would be required each year to comply with the NHCPs. At \$500 per ton, NO_x compliance achieved exclusively by purchasing allowances would cost approximately \$4,216,500 per year. This “high cost” scenario would add about 0.09¢ per kWh to customers’ bills, or 43¢ per month for a household using 500 kWh monthly. In reality, however, under the NHCPs the NO_x controls that are already installed on New Hampshire’s power plants are likely to be operated at their higher control efficiencies year-round rather than just seasonally. Complying with the NHCPs’s annual NO_x emission cap of 3,644 tons in this fashion would add only the incremental cost of operating throughout the year, which NESCAUM has estimated to be about \$168 per ton.¹⁵⁷ Reducing 8,433 tons of NO_x in this manner would thus cost about \$1,416,744 per year, or only about 15¢ per month for a 500 kWh per month household.

As discussed previously, evidence from the field increasingly suggests that steps taken to control one pollutant may lead to reductions in other pollutants. For example, EPA’s ICR results for mercury, although not yet formally released, apparently indicate that certain NO_x controls, coupled with certain SO₂ controls, also reduce mercury emissions substantially with no incremental cost. Further, because the NHCPs recommends trading, sources will have a financial incentive to over-comply with its provisions (through the installation of controls), because doing so will create a potential revenue stream.

¹⁵⁶ Cantor Fitzgerald Environmental Brokerage Services, *SO₂ and NO_x Market Price Index*, December 27, 2000. See <http://www.cantor.com/ebs/>

¹⁵⁷ Northeast States for Coordinated Air Use Management, *Status Report on NO_x Control Technologies and Cost Effectiveness for Utility Boilers*, June 1998. See <http://www.nescaum.org/archive.html>

13.2. Estimated Mercury Control Costs

Costs incurred for the purpose of reducing mercury emissions from existing coal-burning power plants will advance the goals not only of the NHCPS, but also the October 1998 *New Hampshire Mercury Reduction Strategy*. Many of the cost estimates calculated in this chapter share this trait; here they are computed and attributed solely to the NHCPS, but they actually provide multiple benefits for the citizens of New Hampshire that would otherwise cost more – often much more – to achieve separately.

In 1998, the *Mercury Reduction Strategy* estimated mercury control costs using activated carbon injection to be approximately \$19 million in capital cost plus \$6.4 million annually.¹⁵⁸ Also in 1998, NESCAUM suggested that the total annual cost (including capital) for controlling mercury emissions using activated carbon injection technology would be 0.017-0.176¢ per kWh.¹⁵⁹ Using the high end of this range to be conservative, this cost would amount to approximately \$8,552,275 per year, or 88¢ per month for an average 500 kWh per month household, or about \$10.56 per year.

Illustrating the march of technological progress, NESCAUM now estimates that controlling mercury emissions using enhanced wet scrubbing technology will incur capital costs between \$27,000 and \$61,000 per pound.¹⁶⁰ Using the conservative higher figure, the 246-pound reduction that the NHCPS recommends for New Hampshire power plants would cost approximately \$15,006,000. Amortized over 20 years at 10 percent interest, this amounts to approximately \$1,762,600 per year. Adding operating costs of \$2,429,624 per year ($\$0.50/\text{MWh}^{161} \times 4,859,247 \text{ MWh}$), the total cost is estimated at \$4,192,224 million per year, which is about 43¢ per month for an average 500 kWh per month household, or about \$5.18 per year. The major advantage of using enhanced wet scrubbing technology is that it provides the co-benefit of substantially reducing SO₂ emissions at the same time.

Still newer technologies are emerging, however, that promise even greater cost-effectiveness by controlling multiple pollutants at the same time. Independent testing in May 2000 of a new technology patented by Powerspan Corporation¹⁶² – a New Hampshire high-technology company – confirmed that a pilot installation on a 2 MW slipstream from FirstEnergy's R.E. Burger Generating Plant in Ohio achieved extraordinary reductions in mercury (81.6 percent) and fine particulate matter (96.6 percent), and reduced SO₂ by an average of 44 percent and NO_x by 76 percent. Other toxic emissions were also reduced dramatically. This company is now engineering a larger, \$11.9 million installation scheduled to begin operation in the spring of 2001 on a 50 MW slipstream from FirstEnergy's 1,289 MW Eastlake Generating Plant near Cleveland, Ohio. Powerspan's technology is expected to cost 25 percent less to install,

¹⁵⁸ New Hampshire Department of Environmental Services, *New Hampshire Mercury Reduction Strategy*, October, 1998, p. 22. See <http://www.des.state.nh.us>

¹⁵⁹ Northeast States for Coordinated Air Use Management, *Status Report on NO_x Control Technologies and Cost Effectiveness for Utility Boilers*, June 1998. See <http://www.nescaum.org/archive.html>

¹⁶⁰ Northeast States for Coordinated Air Use Management, *Assessment of Mercury Control Strategies for Electricity Generating Boilers*, June 2000. See <http://www.nescaum.org/archive.html>

¹⁶¹ Northeast States for Coordinated Air Use Management, *Environmental Regulation and Technology Innovation: Controlling Mercury from Coal-Fired Boilers*, September 2000, p. V-2.

¹⁶² Powerspan Corp., *Technology: ECO for Coal Background*, 2000. See http://www.powerspancorp.com/technology/scrubber_background.html

and 50 percent less to operate, than NO_x-only control technologies like SCR. As stated above, NO_x compliance achieved exclusively by purchasing allowances would cost approximately \$4,216,500 per year. Thus, with Powerspan technology, reductions of mercury, fine particulate matter, SO₂, and NO_x could cost as little as \$3,162,375 per year (25 percent less than \$4,216,500 per year).

13.3. Estimated CO₂ Control Costs

Regarding CO₂, DES believes that an international CO₂ allowance trading program is likely to develop by 2008. Several emissions trading and brokerage firms, including Cantor Fitzgerald¹⁶³ and NatSource, are already engaging in commercial CO₂ transactions.

Assuming no change in the historical operating profiles of New Hampshire's fossil fuel-burning power plants, and assuming that compliance with the NHCPS is achieved solely by purchasing CO₂ allowances, approximately 532,169 CO₂ allowances per year would need to be secured. Cantor Fitzgerald indicates that CO₂ is now trading in the \$1-2 per ton range, and it estimates the average cost for companies to make the necessary CO₂ reductions internally to be about \$20 per ton. Using an even more conservative cost estimate of \$25 per ton, the "high cost" scenario for this NHCPS requirement would be about \$13,304,225 per year. This amounts to 0.27¢ per kWh or about \$1.37 per month for a household using 500 kWh per month.

Realistically, however, many of New Hampshire's older power plants are likely to operate less frequently after new, more efficient combined cycle generating capacity comes on line, so this cost estimate – as well as those for SO₂, NO_x, and mercury – are apt to be substantially overstated. For example, if the combined annual output from New Hampshire's existing fossil fuel-burning power plants were reduced just 10 percent from 4,859,247 MWh to 4,387,874 MWh annually (not an unlikely scenario once new plants begin operating), the CO₂ reductions resulting from this drop would eliminate the need for CO₂ allowance purchases.

13.4. Summary of Estimated Costs

Most of the above pollutant-by-pollutant cost analyses ignore the opportunity for cost-effective "co-benefits" that result when emission controls intended for one pollutant simultaneously diminish emissions of another pollutant. For example, operating the existing NO_x control equipment year-round at 10 percent lower generation levels would necessitate only 7,260 tons of NO_x allowances to comply with the NHCPS rather than 8,433 tons. At \$168 per ton, this would cost about \$1.22 million per year. Further, if mercury is controlled through the use of enhanced wet scrubbing technology at 10 percent lower generation levels at a cost of \$3,956,537 per year (\$1,762,600 + (\$0.50/MWh x 4,387,874 MWh)), then there would be no additional SO₂ compliance cost because this technology also addresses SO₂ emissions. Under this low cost scenario, costs would total \$5.17 million per year, about 0.6 percent of PSNH's 1999 revenue of \$854 million. This amounts to about 59¢ per month in a 500 kWh household, or about \$7.08 per year for that household.

¹⁶³ Cantor Fitzgerald Environmental Brokerage Services, *Greenhouse Gas Trading, Portfolio Approach Example*, 2000. See <http://www.cantor.com/ebs/>

On the other hand, even the worst-case, high-cost scenario seems reasonable, particularly for those afflicted with respiratory or cardiac ailments or the parents of an asthmatic child. Assuming generation output from the existing power plants were maintained at 4,859,247 MWh, and assuming that absolutely no “co-benefit” effects occur, then as calculated above, SO₂ allowance costs would be approximately \$2.8 million per year, NO_x allowances would be about \$4.2 million per year, mercury control costs would be approximately \$8.55 million per year, and CO₂ compliance costs for the NHCPS would be about \$13.3 million per year. The total for this high-cost scenario would be approximately \$29 million per year, about 3.4 percent of PSNH’s 1999 revenue of \$854 million. This amounts to about 0.60¢ per kWh, roughly \$2.97 per month for a household using 500 kWh per month, or about \$35.69 per year for the family in that household.

Based on recent studies and emerging technology, significant “co-benefits” under an integrated, multi-pollutant emission reduction strategy like the NHCPS are obvious, and DES believes that total costs will be far below the high-cost scenario described above. Additionally, compliance costs could be further reduced through operational changes and the trading of emission reductions achieved above and beyond immediate compliance requirements. As a result, DES anticipates that costs will be near the low end of the above range, if not lower. A cost of \$7.08 per year for an average New Hampshire household seems to be a small price to pay for the numerous health, environmental, economic, and quality of life benefits that the NHCPS provides. With higher electric bills, businesses can anticipate a correspondingly higher cost range than homeowners, but businesses will also reap the benefits described in Chapter 12, including several critical to their success – greater ability to attract and retain employees to New Hampshire’s high quality of life, lower health care costs, less likelihood of economic sanctions due to nonattainment under the Clean Air Act, etc. In addition, we expect that businesses will be able to offset any potential increases in energy costs by pursuing many energy efficiency and conservation measures.

TABLE 13-1. Range of Cost Estimates for the NHCPS

| Pollutant | “Low”* Total \$/year (Million) | “High”* Total \$/year (Million) | “Low” cents/ KWh | “High” cents/ KWh | “Low” \$/month (500 KWh) | “High” \$/month (500 KWh) | “Low” \$/year (500 KWh/month) | “High” \$/year (500 KWh/month) |
|-----------------|---|--|------------------------|-------------------------|-----------------------------------|------------------------------------|--|---|
| SO ₂ | 0.00 | 2.82 | 0.000 | 0.058 | 0.00 | 0.29 | 0.00 | 3.48 |
| NO _x | 1.22 | 4.22 | 0.028 | 0.087 | 0.14 | 0.43 | 1.68 | 5.21 |
| Mercury | 3.95 | 8.55 | 0.090 | 0.176 | 0.45 | 0.88 | 5.40 | 10.56 |
| CO ₂ | 0.00 | 13.30 | 0.000 | 0.274 | 0.00 | 1.37 | 0.00 | 16.44 |
| <i>Total</i> | 5.17 | 28.89 | 0.118 | 0.595 | 0.59 | 2.97 | 7.08 | 35.69 |

- * - “Low” options divide “Low Total \$/year” costs by 4.39 million MWh generation.
 Some costs zero due to multiple pollutant “co-benefits” and/or reduced operations.
 - “High” options divide “High Total \$/year” costs by 4.86 million MWh generation.

14. CONCLUSION

Developed at the direction of Governor Jeanne Shaheen, and following over six months of analysis and research, DES puts forth the New Hampshire Clean Power Strategy (NHCPS) as an aggressive, yet cost-effective plan to secure substantial reductions in harmful NO_x, SO₂, mercury, and CO₂ pollution from New Hampshire's existing fossil fuel-burning power plants. NO_x, SO₂, mercury, and CO₂ are air pollutants that are responsible for premature deaths and other serious human health impacts; harmful ecosystem impacts including reduced forest and agricultural productivity; negative economic impacts to New Hampshire's recreation industry through regional haze, lake eutrophication, impaired fish and wildlife habitat, and fish consumption advisory warnings; and the growing impact of climate change. Collectively, by impairing public health, environmental quality, and economic activity and productivity in the State, these pollutants endanger the high quality of life that New Hampshire citizens enjoy, and the State's quality of life comprises one of the key underpinnings of New Hampshire's economic success in today's high technology economy.

The NHCPS's focus on the electric generating sector is appropriate. When the federal Clean Air Act was reauthorized in 1977, more stringent emissions requirements were imposed on new power plants than on older units on the grounds that the latter would soon be retired from service. In reality, however, this promise has not been kept. The older, dirtier power plants that were "grandfathered" under this provision of the Act have been operated well past their expected lives and continue to emit pollution at much higher emission rates than new electric generating facilities. Increased scientific understanding of the public health and ecological effects of power plant pollution, coupled with the effects of the deregulation of the electric power plant industry, necessitate action to redress this inequity.

Although much of the air pollution that afflicts New Hampshire's citizens and its natural environment originates in upwind jurisdictions, the most effective way for New Hampshire to secure emission reductions in these jurisdictions is to lead by example in demonstrating the feasibility and cost-effectiveness of achieving such reductions. The success of this approach has been demonstrated time after time, most recently in the case of NO_x emissions, where the dramatic reductions achieved by New Hampshire's power plants were instrumental in the process leading to EPA's 22-State NO_x Transport SIP Call.

Such environmental leadership must be exercised wisely, however, so that the pursuit of power plant pollution reductions – and their schedule for implementation – does not impair electric system reliability or increase consumer costs unreasonably. In order to accomplish this, electric generating companies need to know – with substantial lead time – what environmental requirements will face them in the future. This is particularly true in New Hampshire, where PSNH's electric generating assets are about to be divested at auction. Since the proceeds of this auction will reduce the amount of stranded costs that must be paid by consumers, the State has a strong interest in maximizing the auction value of these assets. DES recognizes this interest, and – based on conversations with prospective buyers – believes that the greater regulatory certainty that the NHCPS provides will help avoid "fear-based discounting" on the part of bidders.

In addition, generators need to be able to deal with emission reduction requirements comprehensively – in an integrated fashion involving multiple pollutants – rather than facing serial, pollutant-by-pollutant regulatory requirements that increase both difficulty and cost. The NHCPS aims to fulfill this need cost-effectively, by taking full advantage of the opportunity for economic and environmental co-benefits that arise under its integrated, multi-pollutant approach.

The previous chapters demonstrate that reducing pollutant emissions from power plants is both necessary and feasible. Even with such reductions, however, some pollution will still emanate from power plants for the indefinite future. Thus it is equally imperative, and equally feasible, to use the electricity that we do generate as productively and efficiently as possible. By reducing the need for electricity at the demand point, energy efficiency eliminates (1) all emissions associated with generating the electricity; (2) the cost to ratepayers associated with buying the electricity; and (3) the diminished quality of life associated with breathing those emissions, bearing those costs, and the degrading of our natural resources which are so important to the citizens and businesses of New Hampshire. These benefits accrue without reducing the effectiveness with which lights illuminate, appliances operate, motors rotate, or computers communicate. Through two recent orders of the New Hampshire Public Utilities Commission,¹⁶⁴ the State is on the threshold of realizing more of the economic and environmental promise of energy efficiency.

Power plants, of course, are not the only sources of air pollution. In the case of some pollutants, they are not even the principal cause. Thus, it is important that New Hampshire continue to seek similarly aggressive emission reductions from other pollution sources. To this end, the State strongly supported the new, more stringent national emission standards for light-duty motor vehicles adopted by EPA in December 1999, and the accompanying sulfur reduction requirements for gasoline. The State also insisted that EPA adopt similarly stringent requirements for heavy-duty trucks and buses, and similar sulfur reductions in diesel fuel, and EPA finalized this rule on December 21, 2000. Further, the State is considering the adoption of even more stringent motor vehicle requirements for light-duty motor vehicles (through a LEV program) and heavy-duty motor vehicles (via “not-to-exceed” requirements).

The NHCPS represents a new standard of environmental leadership on the part of New Hampshire. Because New Hampshire continues to be plagued by air pollution transported from upwind jurisdictions, it remains critically important that the State maintain its active involvement in regional, national, and international efforts to secure additional emission reductions. In order to encourage the development of a broader geographic strategy for reducing emissions from power plants in an integrated, multi-pollutant fashion, the NHCPS contemplates its own modification (if necessary) to comport with a similarly aggressive regional, national, or international emission reduction program. It also explicitly safeguards DES’s authority and responsibility to address pollutants on an individual basis where, if, and when this approach must be used as a last resort.

The sooner one sets about accomplishing a task, the easier, sooner, and more likely it is to be achieved. So it is with the daunting challenge of clean air. The State of New Hampshire

¹⁶⁴ New Hampshire Public Utilities Commission, Order Nos. 23,574, *Energy Efficiency Programs*, and 23,575, *Allocation of System Benefits Charge*, November 1, 2000. See <http://www.puc.state.nh.us/>

risks to this challenge with the NHCPS – the New Hampshire Clean Power Strategy – a plan that will reduce acid rain-causing SO₂ emissions by 75 percent, ozone-causing NO_x emissions by 70 percent, toxic mercury emissions by 75 percent, and climate changing CO₂ emissions by 7 percent below 1990 levels. New Hampshire must take responsibility for its own emissions, while simultaneously continuing its efforts at the regional, national, and global level to bring about similar pollution reductions, wherever emitted, which may affect air quality – and our quality of life – in New Hampshire.

APPENDIX 1

Potential Impact of Varying Control Levels and Allowance Price on PSNH SO₂ Compliance Costs Under the NHCPS

| | Title IV Phase II | 75% Further Reduction |
|---|---|--|
| | <u>SO₂ Requirement</u> (11.46 lb SO ₂ /MWh) | <u>Title IV Phase II</u> (3.0 lb SO ₂ /MWh) |
| Estimated Total SO₂ Emissions¹ | 55,686 tons/year | 55,686 tons/year |
| Federal Compliance | | |
| SO ₂ Emissions Allowed by Title IV | 29,566 tons | 29,566 tons |
| SO ₂ Allowances Needed for Federal Compliance | 26,120 tons | 26,120 tons |
| State Compliance | | |
| SO ₂ Emissions Allowed by State | ---- | 7,288 tons |
| SO ₂ Allowances Needed For NHCPS Compliance | ---- | 48,398 tons |
| Net Incremental Emissions Reduction | | |
| Proposed Additional Allowances | ---- | 18,832 tons |
| NHCPS Incremental SO₂ Costs | ---- | \$2,824,800 @ \$150/ton |

Notes:

1. Estimated Total SO₂ Emissions are based on actual 1999 annual emissions.

APPENDIX 2**Potential Impact of Varying Control Levels
on PSNH NO_x Allowance Purchases**

| | <u>Current NO_x Requirements</u> (5 lb NO _x /MWh) | <u>Proposed NO_x Requirements</u> (1.5 lb NO _x /MWh) |
|--|--|---|
| Estimated Total¹ NO_x Emissions² | 12,077 tons/year | 12,077 tons/year |
| NO _x Emissions Allowed by State | 12,882 tons | 3,644 tons |
| NO _x Allowances Needed For NHCPS Compliance (or Surplus) | (805) tons | 8,433 tons |
| NO _x Allowance Costs ³ Based on Purchasing Allowances | (\$ 402,500) | \$4,216,500 @ \$500/ton |
| NO _x Costs ⁴ Based on Running SCRs and SNCR Annually | \$0 | \$1,416,744 @ \$168/ton |

Notes:

1. All figures reflect annual emissions, except the current rate of 1.8 lb NO_x/MWh is based on current optimum monthly rate
2. Estimated Total NO_x emissions are based on actual 1999 emissions.
3. Cost of NO_x allowance estimated to be less than \$400 per ton (cost as at November 2000).
4. Difference between seasonal and annual NO_x control costs estimated to be \$168 dollars per ton based on NESCAUM, *Status Report on NO_x Control Technologies and Cost Effectiveness for Utility Boilers*, June 1998.

APPENDIX 3

Example of Ratepayer Impact Calculations

Note:

- Higher cost scenarios use annual existing fossil generation of 4,859,247 MWh (1999)
- Lower cost scenarios, assuming that approximately 10 percent of PSNH's annual existing fossil generation is displaced by power from new, cleaner facilities, use 4,387,874 MWh.

Example:

- Cost to comply with NHCPS's SO₂ cap by purchasing allowances is estimated to be \$2,824,800 (*see Section 13.1*)

- Cost per kWh:

$$\begin{aligned} \text{¢/kWh} &= \frac{\$2,824,800}{4,859,247 \text{ MWh}} \times \frac{1 \text{ MWh}}{1,000 \text{ kWh}} \times \frac{100 \text{ ¢}}{\$ 1} \\ &= 0.058 \end{aligned}$$

- Monthly cost for an average household using 500 kWh per month:

$$\begin{aligned} \text{Monthly Cost} &= \text{¢/kWh} \times 500 \text{ kWh} \\ &= 0.058 \times 500 \text{ kWh} \\ &= 29\text{¢} \end{aligned}$$

- Annual cost for an average household using 500 kWh per month:

$$\begin{aligned} \text{Annual cost} &= \text{Monthly Cost} \times 12 \text{ months} \\ &= 29\text{¢} \times 12 \\ &= \$ 3.48 \end{aligned}$$

APPENDIX 4

Table of Estimated Reductions (Many Tentative) of Multiple Pollutants

Source: NHDES-ARD

| Pollutant | CEG ¹⁶⁵ Phase 1 | CEG Phase 2 | NEGC/ECP Phase 1 | NEGC/ECP Phase 2 | CATF | CT Phase 1 | CT Phase 2 | MA ¹⁶⁶ Phase 1 | MA ¹⁶⁷ Phase 2 | NY ¹⁶⁸ Phase 1 | NY Phase 2 | NY Phase 3 | NH |
|-----------------------|---|--|---|---------------------|--|---|---|---|---|---|---|---|---|
| NO_x | Seasonal SIP Call; 0% reduction ¹⁶⁹ ; 4.22 million ton national annual cap & trade; 0.15 lb/mmBtu applied to projected 2007 seasonal heat inputs by 2004 | Annual SIP Call; 50% reduction; 2.11 million ton national annual cap & trade; 0.15 lb/mmBtu applied to projected 2007 annual heat inputs by 2008 | Annual program; 20-30% reduction; 0.30 lb/mmBtu applied to current heat inputs by 2007 ¹⁷⁰ | (None) | 1.5 lb/MWh applied to current outputs by 2003, 2005, or 2007 | Annual program; 20-30% reduction; no annual cap; trading allowed; 0.15 lb/mmBtu applied to current heat inputs by 2003 | (None) | Annual program; 45-50% reduction; 1.5 lb/MWh applied to current outputs by 2004 | (None) | Annual program; 25% reduction from current emissions by 2003; 60,000 ton cap & trade | (None) | (None) | Annual program; 70% reduction; 3,644 ton cap & trade; 1.5 lb/MWh applied to current outputs by 2006 (90% lower than 1990 emissions) |
| SO₂ | 50% reduction by 2008 from Phase II Acid Rain; 4.5 million ton national annual cap & trade | (None) | 50% reduction by 2010 from Phase II Acid Rain | (None) | 3.0 lb/MWh applied to current outputs by 2003, 2005, or 2007 | 0.50 lb/mmBtu applied to current heat inputs by 2002 (30% from Phase II Acid Rain); no annual cap; little trading allowed | 0.30 lb/mmBtu applied to current heat inputs (50% by 2003 from Phase II Acid Rain); limited trading allowed | 6.0 lb/MWh applied to current outputs by 2004; 40% reduction from current emissions | 3.0 lb/MWh applied to current outputs by 2006; 70% from current emissions | 25% reduction by 2003 from Phase II Acid Rain; 210,000 ton cap & trade (with some restrictions) | 35% reduction by 2005 from Phase II Acid Rain; 182,000 ton cap & trade (with some restrictions) | 50% reduction by 2007 from Phase II Acid Rain; 140,000 ton cap & trade (with some restrictions) | 3.0 lb/MWh applied to current outputs by 2006; 75% from Phase II Acid Rain; 7,289 ton cap & trade |

¹⁶⁵ Consolidated Edison & Northeast Utilities are members of the Clean Energy Group. This is a tentative national proposal.

¹⁶⁶ MA proposed rule potentially subject to litigation; tentative.

¹⁶⁷ MA proposed rule potentially subject to litigation; tentative.

¹⁶⁸ NY has not published a proposed rule yet, so entries are based on communications with NYDEC; tentative.

¹⁶⁹ CEG Phase 1 proposal requires little if any additional reduction from NH power plants since 2000 emissions are expected to be below 2004 SIP call levels.

¹⁷⁰ Current commitments = 1999 PSNH OTC 5-month Ozone Season allocation of 4,674 tons plus NH non-ozone season cap of 8,208 tons, or 12,882 tons

| Pollutant | CEG Phase 1 | CEG Phase 2 | NEGC/ECP Phase 1 | NEGC/ECP Phase 2 | CATF | CT Phase 1 | CT Phase 2 | MA Phase 1 | MA Phase 2 | NY Phase 1 | NY Phase 2 | NY Phase 3 | NH |
|-----------------------|---|---|---|------------------------------------|---|---------------|---------------|---|---------------|---------------|---------------|---------------|---|
| Mercury | 50% reduction by 2008 from current ¹⁷¹ emissions | 70-90% reduction by 2012 from current emissions | 20-50% reduction by 2005 from 1995 ¹⁷² | 60-90% reduction by 2010 from 1995 | 50% reduction from 2000 levels by 2003, 2005, or 2007 | (None) | (None) | TBD* | (None) | (None) | (None) | (None) | 75% reduction by 2006 from current ¹⁷³ emissions |
| CO₂ | Return to 1990 levels by 2008 | TBD* by 2012 | (None) | (None) | Reduce to 7% below 1990 levels by 2003, 2005, or 2007 | (None) | (None) | 1600 lb/MWh applied to current outputs by 2006 ¹⁷⁴ | (None) | (None) | (None) | (None) | Reduce to 7% below 1990 levels by 2006; (~10% below current ¹⁷⁵ emissions) |

* TBD – Reduction target consistent with national reduction target determined by Congress and/or EPA.

¹⁷¹ Assumption: Current mercury emissions = 1996 mercury emissions from Schiller Station and 1997 mercury emissions from Merrimack Station.

¹⁷² Assumption: 1995 mercury emissions = 1996 emissions from Schiller Station and 1997 emissions from Merrimack Station.

¹⁷³ Assumption: Current mercury emissions = 1996 mercury emissions from Schiller Station and 1997 mercury emissions from Merrimack Station.

¹⁷⁴ Assumption: 1600 lb/MWh represents approximately 93% of 1990 power plant CO₂ emissions.

¹⁷⁵ Derived by taking 93% of 1990 NH CO₂ emissions of 5,425,866 tons (Source: US EPA Acid Rain Division) and comparing it to 1999 NH CO₂ of 5,578,224 tons.